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THE NEW YORK ZOOLOGICAL PARK.

ANYONE making a visit to the New York Zoological Park, of a Saturday afternoon, will be delighted with the extent of the grounds and the happy condition of the animals which are so considerately cared for there. Some great lovers of animals can seldom be induced to visit a menagerie, for their sympathetic natures are struck with the cruelty of confining these wild, liberty-loving beasts in cages barely large enough for them to turn about in. At this park, however, no such criticism can be made, for the aim of the Zoological Society is to preserve as nearly as possible the conditions of nature and give the animals the widest possible range. On account of their freedom and the surroundings suitably adapted to their requirements, the animals here preserve a great many characteristics of their wild state, which are lost among those that are confined in narrow cages. The Society has pretty closely adhered to its policy of keeping only those animals which have been captured wild. For this purpose successful expeditions have been made to Florida and Alaska, where valuable specimens were secured.

Large tracts of land have been reserved for herds of buffaloes and the different species of deer. Wild sheep and goats are given the freedom of a rough granite slope which has recently been prepared for them. A thrifty young cedar tree surrounded by an iron fence affords a happy playground for a number of raccoons, a rustic shelter at the base of the tree serving as a home for the animals. The beaver family evidently feel perfectly at home in their quarters, for they have built a forty-foot dam, with the characteristic upstream curve at the lower end of their pond. They have cut down all the smaller trees left for them in their inclosure and are now attacking the larger ones. The collection of bears is rapidly increasing. They are captured while young and reared on the grounds. A great deal of interest is shown in the ponderous tortoises from the Galapagos Islands. These monsters are fed during the winter months on pumpkins, carrots, cabbages, etc., and in summer on melons, bananas, tomatoes, etc., a single tortoise usually consuming two large watermelons at a meal.

SIDE CAGES IN THE BIRD HOUSE.

SCULPTURED CORNICE OF REPTILE HOUSE

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A PORTION OF THE ELK HERD.

It would be impossible in this limited space to recount the many species of animals and their individual characteristics. We must, however, give a brief description of the bird life in this park. Birds, of all creatures, must suffer the most from solitary confinement. Their needs, however, are very carefully considered by the Society, and capacious cages have been built in which, by their songs and activity, the creatures show a perfect content and happiness. A large outdoor flying cage is well filled with the birds during the summer weather, and the indoor flying cage in the aquatic birds' house has proven an unqualified success. The latter was built first as an experiment, and has now come to be considered indispensable as a sanitarium. It measures 16 x 40 feet and is 20 feet high. A central fountain feeds a large pool in the floor. The rest of the floor space is covered with sand two inches deep. In this inclosure are kept as many as eighty birds at a time, of thirty different species. As soon as a bird in one of the side cages begins to moult it is removed to this center cage, where it soon picks up, and usually inside of a week is in fit condition to return to its own cage. Occasionally a sick bird is killed by the other inmates, but in most instances it has later been discovered that the bird was suffering from a contagious disease, so that the other inmates of the cage had taken the matter into their own hands and checked its spread. This large indoor inclosure presents a scene of perfect harmony; fights are very rare. In fact, some birds which cannot be kept in their side cages because of their pugnacious habits never fight in the center cage.

It has been the strict policy of the society to accept no animals until quarters have been provided for them, and no difficulty has been experienced in filling the cages as soon as they have been

made ready. The large lion-house is now building, and when ready to be occupied, in July of this year, will bring the park just about half-way toward its completion.

REPORT OF THE BOARD OF VISITORS TO THE NAVAL OBSERVATORY FOR THE YEAR 1901.

IN pursuance to a call issued by the Secretary of the Navy, a meeting of the Board of Visitors to the Naval Observatory was held in Washington, beginning April 9, 1901. The Board was organized by the selection of Charles A. Young as chairman and Ormond Stone as secretary. Another meeting was held in Washington, beginning October 29, 1901. At both of these meetings, and afterward by correspondence, as careful an examination as time permitted was made, directly and by committee, of the condition and needs of the Observatory, and of such other matters as are referred to in the law creating the Board. In this examination the Board was greatly aided by conferences with the Secretary of the Navy, the Superintendent and staff of the Naval Observatory, officers of the Civil Service Commission, and others, all of whom have given the Board their most cheerful assistance. As a result of the deliberations of the Board the following recommendations are respectfully offered for consideration:

ASTRONOMICAL DIRECTOR.

It is recommended that no astronomical director be appointed at present, as a dual headship has been found to work unsatisfactorily, and under the existing law the appointment of an astronomer as sole director of the Observatory—which the Board considers the proper solution of the question—is impracticable.

METHOD OF FILLING VACANCIES.

Vacancies should not be filled among assistant astronomers nor among professors of mathematics in the Navy without examination for each vacancy occurring. For example, the results of a given examination should not be used for filling a subsequent vacancy, except in so far as such results may properly form a part of a new independent examination. No distinction should be made between employés of the Observatory and other applicants. Employés should, however, of course, be at liberty to present evidence of experience or capacity as shown by their work at the Observatory in the same manner as other candidates present similar evidence as shown by their work elsewhere. The responsibilities of the positions of assistant astronomer and professor of mathematics are distinctly different from those of a computer, although much of the required experience may properly be gained in connection with the latter position and be credited in the examinations for the higher positions. At the same time it is important that the positions of computer should be filled by persons whose prime interest is in practical and theoretical astronomy and whose ambition it will be to occupy higher positions in the Observatory. As far as is consistent with the routine needs of the institution, the duties of the computers should be so arranged as to encourage them to prepare for advancement within the Observatory itself. The positions of piecework and of regular computers are essentially of the same nature, and promotion from one of these grades to the other may very properly be made, but always on the basis of merit rather than length of service. In no case should appointments be made to the Observatory merely by transfer from other bureaus or officers in the service, nor should appointments ever be made even temporarily without competitive examination.

WINTER ON THE BUFFALO RANGE.

ASSISTANT ASTRONOMERS.

In accordance with the principles herein stated, instead of recommending the name of a person to fill the vacancy now existing among the assistant astronomers at the Naval Observatory, we recommend that an examination be held with the assistance of the Civil Service Commission, in accordance with an announcement, a copy of which accompanies this report as Exhibit A, the examiners to be the members of the Board of Visitors for the time being. In order to carry this out, it is requested that Departmental Order No. 14 be so modified that employés of the Naval Observatory may have the same right to apply as other persons.

ADMINISTRATION OF THE OBSERVATORY.

We desire to call attention to the fact that the enactment which created the Board of Visitors provides that "the Superintendent of the Naval Observatory shall be, until further legislation by Congress, a line officer of the navy of a rank not below that of captain," thus implying that a change in the law is in contemplation. As every other prominent observatory is under the direction of an astronomer, we wish to record our deliberate and unanimous judgment that the law should be changed so as to provide that the official head of the Observatory—perhaps styled simply "the director"—should be an eminent astronomer appointed by the President, by and with the advice and consent of the Senate, holding this place by a tenure at least as permanent as that of the superintendent of the Coast Survey, or the head of the Geological Survey, and not merely by a detail of two or three years' duration. Only in this way can there be a continuous and effective policy of administration which will insure astronomical work of a high order. In rank, salary, privilege and prestige he should be superior to any other official on the ground.

The limitation in the selection of assistants should also be removed, and the assistants once appointed should be secure against detachment or removal except by the action, for cause, of the director.

The institution should be related to the Navy Department, if continued under its control, in some such way as the Royal Observatory at Greenwich is related to the British Admiralty. It should be put under the control of the Secretary directly, and not through a bureau as at present.

SCOPE AND PLAN OF WORK.

The relation of the United States Naval Observatory to astronomy is unlike that of any other observatory in the country. A private observatory is usually devoted to a special line of work selected by its director, or by the head of one of its departments. This work is then carried on in the manner and in the special directions chosen by the officer in charge. The Naval Observatory, on the other hand, is maintained at the expense of all the people of the United States, and its work should not be entirely determined by the wishes and interests of any one individual; a principal use should be to supply the wants of astronomy by undertaking researches which have been neglected elsewhere, either because they are too expensive or for other reasons. It is believed that the policy of undertaking neglected work, and doing what is most needed and not what is most attractive, would commend itself to Congress, to astronomers and to the people.

The Naval Observatory should co-operate with the other observatories of the country, use its influence to prevent needless duplication of work, and supply important deficiencies in work done elsewhere.

Great care should be taken in preparing a permanent scheme of work, in the preparation of which the opinions of experts in each department should be carefully considered.

Important changes in such a plan should be made only after careful consideration, and should in general relate to details of observation, reduction and form of publication, rather than to objects or classes of investigation. The officers required to carry out this work should be selected for special fitness or experience, as well as for general astronomical knowledge, and a change in duty should be seldom made and then only for important reasons. If any observer has by years of experience attained great skill with a meridian circle, to place him in charge of an equatorial would be much like making a sailing master of an engineer, however skilled he may be. Great care should be taken in the assignment of duties to different members of the observing staff in order to secure a satisfactory distribution of force among the instruments and to avoid undue concentration or the reverse. At the same time the special aptitudes of individuals should be kept in mind, and their interest enlisted by giving them as far as possible independence of responsibility.

The following provisional plan is suggested for criticism and amendment:

The meridian circle is necessarily one of the most important instruments in a government observatory. Daily observations should be made, whenever possible, of the sun and moon, and of sufficient number of standard stars to determine accurately the error of the standard clock and the constants of the instrument. The major planets should be observed on a certain number of nights every year to correct their ephemerides, but not often enough to curtail seriously the other work of the instrument. A system of standard stars should be selected by co-operation with the various national almanacs and observatories, and a certain number of observations of each of these stars should, if possible, be secured each year. In planning the observations, the determination of their absolute and not merely their relative positions should be taken into consideration. In preparing a list of standard stars it is suggested that instead of attempting to observe all stars brighter than a given magnitude, it might be better to take only those of about the same magnitude and spectrum, in order to eliminate errors due to magnitude and color, and to choose those nearly equally spaced in the sky, adding such polar and equatorial stars as will culminate at nearly equal intervals and will not interfere with one another. It would also be necessary to include all the very bright stars as a basis for daylight observations. As examples of special researches that might have been taken up under such a system may be mentioned the comparison stars for Victoria and Sappho proposed by Dr. Gill in 1889, and the comparison stars selected by the Astrophotographic Conference of 1900 for observations of Eros.

The altazimuth instrument should perhaps also be used for observing the moon when off the meridian, and for determining the time when clouds render it impossible to observe on the meridian. The observation of zenith stars should be continued with the prime vertical instrument and vertical circle. These observations, which appear to be of a high degree of excellence, have now lasted eight years, and should be maintained for at least eleven years longer, or through a complete metonic cycle, to furnish a good determination of the constant of nutation. An additional computer is much needed for the reduction of this work.

The determination and distribution of accurate time will always be an important function of a government observatory, and requires a careful administration. Not only is the exact time required for rating the chronometers of the Navy, but at present time signals are distributed by telegraph from the Naval Observatory throughout the country. The value of accurate time to the people generally is so great that no reasonable effort should be spared to reduce the inevitable errors from every source as much as possible. Formerly large sums were expended by railroads, cities, factories and makers of clocks and watches in the purchase of time signals, furnished by various observatories. To many observatories this was an important source of income.

In 1883 the astronomers of the country, recognizing the great value of a system of uniform standard time, used all their influence toward securing its adoption, notwithstanding the obvious danger to their private interests—since under such a system it would be possible for a single institution to furnish time to the whole country. In fact, in 1891 the Naval Observatory assumed the task. While the time as now distributed from the Observatory is sufficiently accurate for most business purposes, since a nonaccumulating error of a few seconds is of little importance in that view, it appears, however, that at considerable distances from Washington the errors are often considerably greater than under the old system, when the time was communicated from a standard clock not very far away, the errors being often large enough to interfere with the utility of the signals for chronometer rating and scientific purposes. The difficultiy lies largely in the methods by which the time is transmitted by the telegraph, but more in the slightly irregular rate of the standard clock through long intervals of cloudy weather during which star observations cannot be obtained.

It would seem that by co-operation with other observatories a considerable improvement might be made, by arranging matters so that every night, or at least on nights during which the weather is bad at Washington, these observatories should each send a time signal to the Naval Observatory, indicating also the intervals since the last observation.

It is difficult to see any way in which the efficiency of the Navy is increased by means of the 26-inch equatorial telescope. If left idle, however, it would be a subject for severe criticism, owing to the large sums of money already expended upon it. Its work should, therefore, be planned wholly in the interests of astronomy. The same principle should be adopted as with the other instruments. Researches should be undertaken which have been neglected at other observatories, duplication of work should be carefully avoided, and no investigation should be undertaken that can be done equally well with smaller instruments. The following examples of the species of work to be undertaken may be mentioned: A list of double stars which are too difficult to be observed with small instruments, and of which no recent accurate measurements have been made, should be prepared with the advice of specialists in this department, and measured with the greatest accuracy; binaries and suspected binaries should, of course, receive special attention; neglected asteroids and variables should similarly be followed; the observations of the satellites should be continued with this instrument, especially those of Saturn and Uranus, which are likely to be neglected at European observatories for the next few years owing to their southern declinations.

Lost asteroids, and perhaps others, can best be found and followed by photography. The spectroscopic approach and recession of the stars is at the present time under investigation with so many very large telescopes that this work may be left to them. The number of known spectroscopic binaries, however, is so great that it may be necessary hereafter to follow them carefully to determine the laws governing their motions. The work of the 12-inch equatorial should supplement that of the 26-inch.

In general the plan of work should be altered but rarely, and then only when changes seem imperative. Special attention should be given to work neglected elsewhere, and every effort made to render our knowledge of astronomy as complete as possible.

AMERICAN EPHEMERIS AND NAUTICAL ALMANAC.

Among the most important scientific publications of the Government of the United States are those issued by the Office of the American Ephemeris and Nautical Almanac. The first and best known is the Almanac issued every year, which gives name to the office. Four European countries—Great Britain, Germany, France and Spain—make similar publications, and a great sav-

ing might be effected by carrying still further the plan of co-operation already in part adopted. To avoid errors certain elements are computed independently three times, but if this is done for all five of the almanacs evidently much work is wasted. So far as possible the same quantities should be published in all of the almanacs, and computed independently as many times as may be deemed necessary. Ninety-six pages are devoted to that important and laborious problem, the exact path of the moon. Here an independent computation seems needless when we consider that the only American observatory at which the position is regularly determined is at Washington. The occasional observations made at other places have, in general, but little permanent value, and for observations of the moon at sea far less accurate positions are needed. In fact, 72 additional pages are devoted to lunar distances. In order that the saving suggested may be accomplished without delaying the publication of the Almanac, arrangements should be made with the foreign almanac offices to complete their computations at least a year longer in advance than is done at present.

A second most important consideration is that changes should be made only after a most careful examination and consultation with astronomers for whose benefit the Almanac is printed, and with the approval of the Board of Visitors. Changes not only cause great inconvenience, but often render it necessary to employ some other almanac when reducing the observations extending over a long period of years. The changes suggested below are so extensive that they should be made only if approved by American astronomers in general.

Washington mean time is not used even at Washington, and its use in the Almanac seems superfluous. Greenwich mean time, as modified in standard time, is in universal use in the United States, and is already used in a large part of the Almanac. Central time, which differs from Greenwich time by exactly six hours, might be conveniently used to simplify the interpolation for the transits of the moon and planets.

The phase angle, *i*, should be given for the outer planets as well as for Mercury and Venus.

The ephemerides of the satellites are often insufficient for even the identification of these bodies. This is particularly the case with Hyperion and Iapetus. For the latter even the apparent ellipse is not given. It will probably not be necessary to return to the bulky tables of the satellites of Jupiter, published yearly in the Almanac before 1882. It will be convenient to have the correction to the ephemeris given when it is known—for instance, the ephemeris of Mimas for this year (1901) is in error by about four hours. Accordingly it is invisible on account of the ring at the predicted times of elongation.

The published positions of observatories should be changed only after careful consultation with the directors. If a system of longitude like that of the Coast Survey is adopted, it should be so stated in the description. The statement that "the latest available data have been used" is too indefinite.

A great saving in expense might be effected by the adoption of some of the changes mentioned above. This would permit the insertion of valuable data now omitted. For instance, the list of star places might be greatly extended, ephemerides for physical observations of the moon and planets might be inserted, and approximate ephemerides of Eros and of some of the more interesting asteroids, such as Hungaria, Tercidina, Sirona and Polyhymnia.

It is recommended that these and similar changes be proposed to astronomers, and that they be invited to suggest others, as was done by Prof. Newcomb when taking charge of the office.

A series of papers of very great scientific value, entitled "Astronomical Papers prepared for the use of the American Ephemeris and Nautical Almanac," has been issued by this office during the last twenty years. The "Contribution to Celestial Mechanics," made while the office was under the direction of Prof. Newcomb, was a notable one, and a continuation of the papers mentioned is greatly to be desired. A continued investigation of the motion of the moon is especially recommended.

INSTRUMENTS.

The Board at its meeting in April appointed a committee which made as careful an inspection of the instruments of the Observatory as was possible during the time at its disposal. On the whole, the 26-inch equatorial is in good condition. It is recommended that this instrument be supplied with a micrometer at least equal in quality to that constructed for the large equatorial of the Pulkowa Observatory. Also a good field illumination should be provided, as well as a symmetrical illumination for the wires.

Since the visit of the committee in April a number of improvements have been made on the 12-inch equatorial; a bright field illumination is still needed. An investigation of the object glass, which gives poor stellar images, is now in progress by Mr. King, the officer in charge. This examination will show whether the glass is merely out of adjustment or should be refigured.

Extensive repairs are needed for the 9-inch transit circle, and especial attention is invited to Exhibit B, which gives a list of the most important improvements referred to.

A number of changes have been made in the 6-inch transit circle; these and others still needed are referred to in Exhibit C. For both transit circles collimators should be provided having object glasses of larger apertures, and also better means should be provided for obtaining the necessary meteorological data.

The prime vertical transit should be provided with a long focus lens and an azimuth mark. The house containing the altazimuth is too small. The present building should be replaced by one of such size that collimators may be placed inside of the dome, and, as in the case of the prime vertical, a long focus lens and an azimuth mark should be provided.

For use with the meridian and prime vertical instruments three new chronographs are needed.

Special attention is called to the importance of a careful study of each instrument of the Observatory and a prompt publication of the results of such investigations.

LIBRARY.

The Library contains 18,025 bound volumes and 3,891 pamphlets. It is devoted to astronomy and mathematics, and the allied sciences, and is particularly rich in complete sets of the publications of observatories, academies, and learned societies of Europe, many of which are rare, as well as modern treatises and reports of investigations. It is admirably arranged and is in excellent order. The assistant librarian in charge has made considerable progress in the preparation of a comprehensive card catalogue, which will render the material on the shelves much more available.

The appropriation of $750, which is now provided for the Library, is not sufficient for its needs. About $350 of this is required to keep up the scientific journals and the works, such as yearbooks, which appear periodically. The remainder of the appropriation is not sufficient to provide the new books, engravings, photographs, and fixtures required, and to fill up gaps in the Library when special opportunity offers. It is recommended that the appropriation be increased to $1,000.

ADDITIONAL REQUIREMENTS.

In the opinion of the Board, there is urgently needed:

1. A repair shop for the instrument maker.
2. Residences for those who are regularly engaged in the late night observations.

EXPENDITURES.

The expenditures for the Naval Observatory are presented in Exhibit D.

From the manner in which the appropriations have been made, it is not easy for the Board of Visitors to determine what portion of the expenditures pertains properly to astronomical work, what portion to naval work, and what portion to the improvement and care of the grounds as a park.

Respectfully submitted,

CHAS. A. YOUNG,
CHAS. F. CHANLER,
ASAPH HALL, JR.,
E. C. PICKERING,
ORMOND STONE,
WILLIAM R. HARPER.

THE MANUFACTURE OF CYANIDES.

INCREASING interest attaches to the manufacture of cyanides at the present time, mainly from two distinct standpoints, which, briefly stated, are the greatly-extended application of the potassium salt in gold mining and the recovery of cyanogen compounds from the spent oxide of gas works—a material which contains them in varying forms and amounts. Of the use of potassium cyanide in the extraction of gold we do not propose to say anything—at least, as regards the *rationale* of the process—as there is nothing much to say that would have the impress of novelty. It is rather with the preparation of this and other important cyanides that we are concerned to-day, the amount of attention which manufacturing chemists and gas engineers have of late years given to the subject seeming to denote that some general considerations and remarks on the present position would not be without interest to those whose acquaintance with this particular field of research and industry is academic rather than practical and up-to-date.

Although carbon and nitrogen, the two elements of which cyanogen is composed, do not unite even under the influence of the electric spark, the combination is effected when certain nitrogenous bodies are heated with an alkali. This is the old commercial method, though potassium cyanide can also be formed by passing a current of nitrogen over a heated mixture of carbon and potash. For many years the cyanides of commerce were obtained altogether by the method mentioned above, the raw material commonly used being hoofs, clippings of hides, waste wool, etc., the salt usually made being the ferro-cyanide of potash, this being obtainable pure more easily than is the deliquescent potassium cyanide. As we have indicated above, however, a complete change has come over the cyanide manufacture, and the utilization of the spent oxide of the gas works is now carried out on the large scale both by firms who buy up the oxide for the purpose and by corporation gas works who work up their own oxide. The ferro-cyanide of potassium is the salt commonly made, and up to recently large quantities of this were used for the preparation of potassium cyanide. This procedure has, however, of late undergone a change owing to the manufacture of potassium cyanide from the sulpho-cyanide by a patented process of the United Alkali Company. This process enables the salt to be produced at a cheaper rate, and it is difficult when we look at the current market prices to see how the manufacture from ferro-cyanide can be made to pay. The ferro-cyanide is quoted at 5½ pence per pound, and to-day potassium cyanide is down to about 9 pence per pound, though it is not long since it was sold at 2 shillings per pound. At this latter figure the old method of manufacture was right enough, but the margin between 5½ pence and 9 pence is not great enough to recommend the business as a paying one. Of course, the potassium cyanide is not the only cyanide salt in demand, as the textile industries absorb a good deal of the ferro-cyanide, and, of course, Prussian blue is a manufacture of importance. It is a point, however, to consider whether the activity now displayed in recovering cyanides from spent oxide may not cause a glut in the market and still further depress the price of the products. Among the gas works now producing crude ferro-cyanide may be mentioned Birmingham and Edinburgh, and one or two of the large tar-distilling concerns are the principal other producers. These latter buy their oxide from the various gas works, the price paid being regulated by the amount of cyanides contained—a figure which is extremely variable. Up to recently this oxide was generally burnt by sulphuric acid makers, the residual oxide of iron being used as an iron ore. Of course, a large amount is still utilized in this way, as it is only that which contains a high percentage of cyanogen that finds a ready sale for anything but acid-making purposes. When the gas company works up its own ammonia for sulphate and makes its own vitriol, it becomes a question as to what is the best policy in disposing of the spent oxide—whether to utilize it as the raw material of the acid manufacturer or to sell it to the cyanide makers, if, indeed, it is not worked up for cyanide on the spot. Such questions, however, must be considered in the light of the special circumstances surrounding each case, and no good would be done by attempting to lay down any fixed rule. Where other sulphur compounds can be cheaply obtained, and the spent oxide is rich in cyanides, it would probably pay best to wash the oxide for cyanides or sell it for this purpose, but it is easily conceivable that conditions might exist which would make it more expedient to sacrifice the cyanides and to use the sulphur. The cyanides in the spent oxide do not exist in any simple or single form; they take various shapes, from Prussian blue to ammonium sulpho-cyanide, and their determination is not a matter to be undertaken lightly by the tyro. When the oxide is used for acid-making, the cyanides, in whatever form they exist, are converted by combustion into carbonic acid and free nitrogen, the sulpho-cyanides, of course, yielding sulphurous acid in addition. Although the purifiers take up a good deal of the cyanogen in the crude gas, yet a certain amount passes into the gas holder; indeed, it has been found that the gas may contain as much as 1 ounce of hydrocyanic acid per 1,000 cubic feet, a fact which goes a long way to explain the corrosive action of gas upon metals, leather, etc. Methods have been proposed, and to some limited extent adopted, to extract the cyanogen compounds from crude gas by the use of rotatory washers placed at the outlet of the tar extractor; but although we are open to correction, we imagine that the amount of cyanide which finds its way into commerce from this source is anything but large compared with that extracted from the spent oxide, or the various special mixtures which are used in place of oxide of iron in the purification of gas. It will cause no surprise when we say that the details followed by the various manufacturers of yellow prussiate, and of cyanide of potassium, at the present are somewhat jealously guarded as trade secrets, and it is, therefore, by no means an easy matter to arrive at any clear knowledge of the existing condition of affairs. It is certain, however, that there is very little chance of many of the patents which have been taken out being worked on the manufacturing scale, and this not only from apprehended difficulties from a technical point of view, but also from the important fact that in many patents which have been taken out it would not be at all an easy thing to prove their validity in a court of law if the claim to novelty were disputed. With regard to recent patents, that of Grossman seems not to deserve the stricture we have just passed, though we are not in a position to say whether the confident predictions of the patentee are being borne out in the results of working. In this patent ammonia forms the nitrogenous material, its interaction with an alkaline sulphide leading to the direct formation of the corresponding alkaline cyanide. A certain amount of cyanogen is always produced during the manufacture of black ash in the Leblanc process; but despite a good many attempts to recover it, none of them have been attended with any degree of success. In this short contribution to what forms an interesting and not at all unimportant branch of our chemical industry, the reasons why we have been unable to go into further detail have been already referred to; but, all the same, it is thought that even in its state of deficiency and incompleteness it will prove of some little interest, if not value, as a contribution to the contemporary literature on the subject.—Engineering.

INDUCED RADIO-ACTIVITY.

VARIOUS solid bodies acquire induced radio-activity when placed in a closed vessel with a radio-active salt of radium. The effects obtained are more regular and more intense when the radium salt is in the form of an aqueous solution. The induced radio-activity is independent of the pressure, and of the nature of the gas in the inclosure. Certain substances, those becoming phosphorescent on exposure to light, and certain others, become luminous when placed in an activating inclosure. If two glass globes be arranged, communicating by a bent tube, and in one a solution of an active barium salt containing a few milligrammes of radium, be put, and in the other a substance such as sulphide of zinc, the zinc sulphide becomes brightly luminous, as much so as when it has just been exposed to an intense light. The luminosity is due to the induced radio-activity communicated through the bent tube, and not to direct radiation from the radium. The intensity of the Becquerel radiation from the zinc sulphide in this experiment is exactly the same as that from a piece of copper or any other substance placed in the same conditions. The glass also becomes phosphorescent by induced radio-activity. The induced radio-activity of bodies placed in an activating inclosure depends essentially on the free space existing around them. An activating inclosure of glass is illuminated entirely, but not equally throughout, the wider portions of the tube being more luminous and more radio-active. The final activity in an inclosure when the limiting value has been reached, perhaps after some weeks, depends only on the quantity of radium which has been introduced in the state of solution, but in a wide inclosure the active state is reached more rapidly. The activity increases in an inclosure when the quantity of activating solution is increased. The power of activation of a solution is thus not analogous to a vapor tension.—P. Curie and A. Debierne, Comptes Rendus.

German Regulation for the Sale of Butter.—Under date of March 6, 1902, Consul-General Guenther, of Frankfort, writes:

The Reichsanzeiger publishes the regulation with reference to the sale of butter in Germany, which will go into effect on July 1, 1902. According to this, it will be unlawful to sell or offer for sale butter which in 100 parts weight contains less than 80 parts of fat or more than 18 parts of water if unsalted, or more than 16 parts of water if salted.

THE ACTION OF ELECTRICITY UPON FROST.

THE influence of electricity upon the precipitation of atmospheric humidity is a question that greatly interests meteorologists, who never allow an opportunity to escape to add to the sum total of our knowledge upon this subject.

Mr. Arthur Marshall, of the chemical service of the Woolwich Arsenal, has recently published a paper in Nature, in which he presents an interesting study of such influence. The author's experiments were performed upon the chalk cliffs of the southeast of England, and had a special bearing upon the subject of the effects produced by static electricity. According to him, such electricity favors the condensation of vapor. Meteorology teaches us that clouds sometimes exhibit motions of a peculiar and somewhat inexplicable nature. During storms or squalls gyratory motions often occur around horizontal axes, and sometimes, even, ragged clouds participate in such motions and seem to be thrown far from the axis. In such whirlwinds meteorologists thought there appeared a phenomenon that facilitates the formation of hail, etc. These two questions seem to be connected, and as they concern the mechanics of the atmosphere in the highest degree, the question has been asked whether there was not some means of more closely studying the action of electricity upon clouds or fogs, the composition of which is identical.

The difficulty of making such studies upon nature itself may be readily conceived. They would require a combination of conditions that would, to say the least, be difficult to realize; for example, a balloon ascent to a sufficient height to permit of studying nature at such a point. It appears certain that if important data ever reach us as the result of such observations, it will be because the fortunate observer will have been favored by the greatest of risks. So we have been led to make laboratory experiments, and the following is the arrangement adopted by us for studying the action of the electric spark upon fogs (Fig. 1):

Upon the independent plate, *H*, of a pneumatic apparatus we place a bell-glass, *C*, provided with two small tubes, *T* and *T'*. In the interior of the bell-glass, upon a cork support, *S*, there is a flask, *V*, which likewise is provided with two lateral tubes, *t* and *t'*. These apertures are closed by rubber stoppers firmly tied to the tubes. The stoppers are traversed by copper wires, *p p'*, the extremities of which may be placed close to or separated from each other. The tubes, *T* and *T'*, of the bell-glass are closed by rubber stoppers traversed by copper rods connected in the interior of the bell-glass with the copper wires of the flask. The external parts of the rods, *T*, and *T'*, are put in communication with the poles of an induction coil. The parts, *B*, *P*, and *I*, of the figure represent respectively the coil, the battery and an interrupting key. The *modus operandi* is as follows: The flask, *V*, is rinsed with cold water, closed by means of a rubber stopper, *f*, and then put in circuit, as shown in the figure. The tube, *R*, is afterward connected with an air pump, and a vacuum formed in the bell-glass.

At a given moment, under the effect of the pressure of the air contained in the flask, the stopper, *f*, gradually rises, and then abruptly flies out. At the same instant, this adiabatic expansion of the air produces a cooling, so that the entire flask becomes filled with a fog that is denser and whiter in proportion as the experiment is more successful. If, then, the suction of the pump be arrested by closing the cock, *R*, the fog will persist for a minute and a half in a flask of 61 cubic inches' capacity. In most cases some of the fog makes its exit slowly from the neck of the flask, expands in the bell-glass, and gradually disappears. The same is the case with the fog that remains in the flask.

We know that the fog and clouds of the atmosphere may result from a condensation by direct cooling, by mixture, or by expansion.

Our method of operation most nearly approaches this latter mode of formation, and places us under conditions more analogous to those of nature. In fact, when a mass of air chances to be carried along in an ascensional motion, its pressure diminishes in measure as it rises. It is the same with the air of the flask, which also soon finds itself in a rarefied atmosphere. The high atmospheric strata are cooled; and the vacuum formed around the flask cools also the surrounding air. If, during its ascent, it neither receives nor loses any heat, its expansion will lower its temperature to such a point as to produce a fog or a cloud. This is what occurs at the moment at which the balloon is uncorked. Such being the case, we endeavored to ascertain the effect of the passage of a spark through the fog. As soon as the latter was formed, we caused a spark to jump at *p p'*. It sufficed for this, rapidly to open and close the interrupting key, *I*. The first thing that we observed was that operation. The first thing that we observed was that the passage of the spark gave rise to a rapid disappearance of the fog. It did not, upon an average, persist more than ten or twelve seconds, and that, too, with two or three sparks only. Did this fog disappear in the air or did it undergo a condensation? In order to assure ourselves of this, we performed the experiment in the following manner. We very carefully dried the walls of the flask, and then, by means of a pipette, introduced a few drops of water in such a way as to wet but a very small portion of the bottom of the flask. We then operated anew with and without a spark. Every time that we did not make the spark jump, the fog was dissipated and

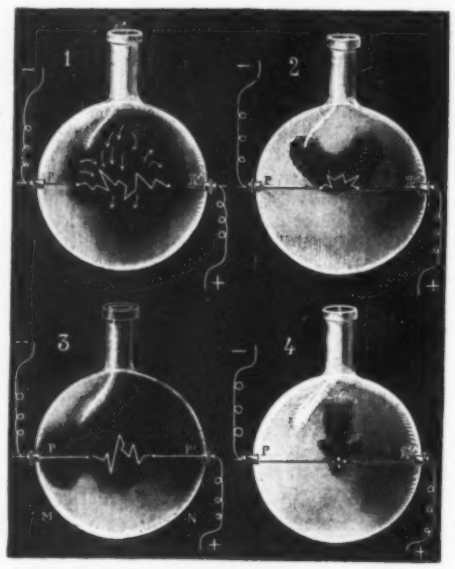


FIG. 2.—RESULTS OF THE EXPERIMENTS.

absorbed by the atmosphere without leaving any trace upon the internal wall of the flask. On the contrary, every time the spark traversed the fog, the latter condensed upon the wall.

We have repeatedly performed these experiments with sparks of different lengths, and all these results have been confirmed. We therefore conclude that a spark in a space containing aqueous vapor in the form of a fog, either very dense or but slightly so, gives rise to a rapid condensation that in a few instants precipitates a quantity of water notably greater than that which would be condensed during the same time by another cause of condensation.

It is not rash, we think, to conclude that an analogous phenomenon must occur on a large scale in nature. Moreover, do we not see in every storm an immediate downpour of rain follow every thunder clap? It might be objected that here it is the drops composing the storm cloud that are themselves electrified, and that, the flash occurring, the cause that opposed itself to the union of the drops disappears, and that the latter then fall through their own weight. But it is none the less true that if we see electricity produce so rapid a condensation on a small scale, such action multiplied to infinity in the colossal forces that we see at times in play over our heads, must singularly contribute toward the re-enforcing of the phenomenon of aqueous precipitation.

It remains for us to call attention to the mode of disappearance of the fog, and which differs according to the length of the spark.

If the spark is from 2 to 2.5 inches in length, there forms between the electrodes, *p p'* (Fig. 2, No. 1), a zone of condensation that appears black by contrast with the surrounding lactescent medium. It extends to 1 or 1.5 inch above and to 0.4 to 0.75 of an inch below the horizontal line joining *p p'*. But, upon watching the phenomenon attentively, we observe a strong eddy in all of this zone, without a very marked direction. Such eddy is soon arrested by the surrounding fog, which seems to fill the gaps produced by the first precipitation. If we localize the effects of the spark by reducing its length (Fig. 2, No. 2), the zone of condensation increases in height and assumes the form of the flame of a butterfly gas-burner. The fog rapidly disappears as usual, beginning at the top of the flask, and the remaining portion becomes stratified as it diminishes.

If we make a spark jump after the fog has exceeded the pole-line, *p p'*, by from 0.4 to 0.75 of an inch (Fig. 2, No. 3), we observe at the same instant a production of two prominences, which approach the copper points, while the intermediate space is quite strongly depressed. It is in this space that the fog disappeared in the first place. At times we no longer see anything therein, except a few whitish filamentous débris floating at *m* and *n* near the walls of the flask. When the spark is reduced to about 0.3 of an inch (Fig. 2, No. 4) there form on the upper side three well marked zones that we cannot do better than compare to the aspect of a clover-leaf, of which the central leaflet has an exaggerated development.

The backflow is intense and extends as far as to 2.4 and 3.1 inches. At the same time, we observe a well characterized gyratory motion in the direction of the displacement. Sometimes, even, cloudlets of vapor are projected outside of the sphere of action.

Finally, if we bring the points, *p p'*, close enough to each other to reduce the spark to 0.75 of an inch or 1 inch, there will be nothing more there than a small line of fire. The condensation in such a case is rapid, and, at the moment that the spark jumps, there occurs a radial backflow in all directions that gives rise to a strong eddy in the entire mass.

Does not all this represent to us on a small scale whirling motions analogous to those that we observe in meteorology, and that we mentioned in the first lines of this article? It is unnecessary to say that the aspect of the different phenomena that we have just described is not stereotyped for each experiment, for too many secondary and variable causes intervene. But upon repeating the experiments a sufficient number of times, we can acquire enough skill in the manipulation of the different parts of the apparatus to reproduce such or such a phase almost at will. It is useless to add that a perfect analysis of the phenomenon requires a preliminary education of the eye, and requires especially a sharp eye quick to perceive. —Prof. Vandevyver, in La Nature.

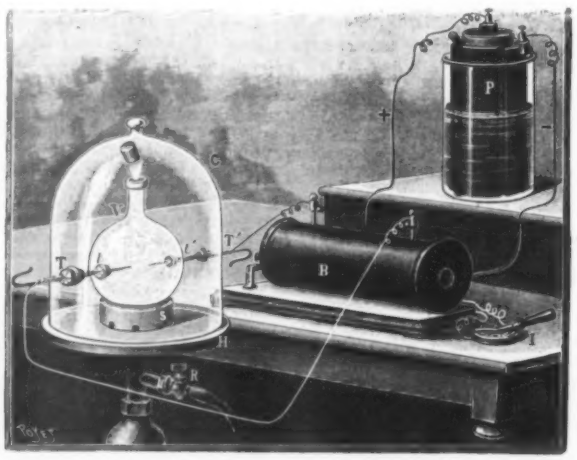


FIG. 1.—ARRANGEMENT FOR EXPERIMENTS UPON THE ACTION OF ELECTRICITY ON FOGS.

ANIMAL PERFUMES AND THEIR ORIGIN.*

By R. LYDEKKER.

ALTHOUGH fashionable enough in former days, the three chief perfumes of animal origin, namely, civet, ambergris, and musk, have steadily declined in popular favor in their unmixed condition, and are now chiefly employed to form a basis for other scents of a less powerful nature. All three are products of mammals, and all appear to have been known from very ancient times indeed, although much misconception was long prevalent with regard to the real origin and nature of the second.

Nowadays naturalists are almost universally in the habit of calling the animals from which the first-named of the three is obtained "civets," although in popular language they are termed "civet-cats." Apparently there is little doubt that the latter usage is correct, the name civet being properly applicable to the perfume itself rather than to the animal by which it is secreted. In a well known dictionary we find for instance, the following:

"CIVET, *n.* [Fr. *civette;* Ar. and Per. *zabad.*] The sweet scent of any beast; a semi-fluid substance taken from under the tail of the civet-cat and used as a perfume. *vt.* To scent with *civet;* to perfume."

"CIVET-CAT, *n.* The animal that produces civet."

Again, in Shakespeare and other early writers the word civet is invariably employed to designate the perfume itself.

Of civet-cats, to give them their full title, there are several distinct species, the typical representative of the group (*Viverra civetta*) being African, while the others are inhabitants of India and the Malay countries. These animals, the largest of which is about the size of a cat, while the smallest may be compared with a pine-marten in size, are near relatives of the genet and the palm-civets, and more distant cousins of the mongooses. Their affinities with the cat tribe are comparatively remote, although, in spite of their long and pointed muzzles, they are much more closely related to those animals than they are to the dogs. They are coarse-haired, flat-sided creatures with small ears, partially retractile claws, a long tapering tail, and generally a crest of long hairs running down the middle of the nape and back. The ground color of the fur is grayish, upon which are streaks or blotches of black or blackish brown, the tail being ringed with black. The most striking and characteristic feature of their coloration is, perhaps, the black gorget on the throat. The civet, which is a white fatty substance, is contained in two small pouches, or infoldings of the skin, situated beneath the base of the tail.

To obtain the civet the animals are kept in confinement inclosed in long cages so narrow that they cannot turn round. Two or three times a week the back of the cage is opened, and the animal dragged by its tail close up to a cross-bar, when the civet is carefully scraped out of the pouches by means of a wooden spoon or spatula. When collected the perfume is carefully inclosed in an air-tight vessel. The amount of civet yielded depends, it is said, to some extent upon the food on which the animal is fed. If the civet be not periodically removed, some of it is discharged by the animal itself; and the walls of the cages of the civet-cats in the Zoological Gardens are frequently smeared with this odoriferous substance, which is carefully collected by the keepers.

A very large amount of commercial civet is yielded by the large African civet-cat, already mentioned, but the large Indian species, or zibeth (*Viverra zibetha*), which derives its name from a corruption of the Arabic and Persian designation of the perfume, is probably equally prolific in this respect. The smaller oriental civets, the smallest of which—the vrasse—has

* Knowledge.

been introduced into Madagascar, yield, of course, a less amount of this valuable substance.

Formerly, at any rate, civet-cats were kept in Holland for the sake of their perfume, as is attested by the following extract from Hutton's translation of Buffon's Natural History, published in 1823:

"In Holland, where no small emolument is derived from their perfume, they are frequently reared. The perfume of Amsterdam is esteemed preferable to that which is brought from the Levant, or the Indies, which is generally less genuine. That which is imported from Guinea would be the best of any, were it not that the negroes, as well as the Indians, and the people of the Levant, adulterate it with mixtures of laudanum, storax, and other balsamic and odorous drugs."

Roughly speaking, about twenty thousand ounces of civet are annually imported into London; of pure Jeddah civet the value is eight shillings and sixpence per ounce, of "commercial" civet seven shillings.

Very different to civet, both in character and in origin, is the substance known as ambergris. The name of this very remarkable substance is of French origin, *ambre-gris*, signifying gray amber, or rather perhaps gray perfume, the word amber itself (Fr. *ambre*) referring to the odoriferous qualities of the substance it designates, as is exemplified by the verb *ambre*, to perfume.

Ambergris is generally found floating on the surface of the sea, and very different ideas have been entertained as to its nature and origin. It appears, however, that so early as the middle of the sixteenth century it was known to have some connection with whales; although the nature of this connection was not fully realized. One writer, for instance, in describing a sperm-whale stranded on the Norfolk coast, expresses his surprise at not finding ambergris in its stomach. Although the idea that ambergris is swallowed by the sperm-whale is erroneous, the writer in question was quite correct in regarding that substance as pertaining to this particular species of cetacean.

A century later the original idea of the association of ambergris with whales seems, however, to have been abandoned in favor of a notion that it was the gum of a tree. On the other hand, in an early edition of Johnson's Dictionary (1818) it is described as being either floating honeycomb or guano.

Buffon, however, was fully convinced of its cetacean origin; and in the translation of his work already cited we find the following passage in connection with the sperm-whale:

"As to the ambergris which is sometimes found in this whale, it was long considered as a substance found floating on the surface of the sea; but time, that reveals the secrets of the mercenary, has discovered that it chiefly belongs to this animal. . . . It is found in a bag of three or four feet long, in round lumps, from one to twenty pounds in weight, floating in a fluid rather thinner than oil, and of yellowish color There are never seen more than four at a time in one of these bags; and that which weighed twenty pounds, and which was the largest ever seen, was found single. These balls of ambergris are not found in all fishes of this kind, but chiefly in the oldest and strongest."

While there is much of truth in this account, there is a certain amount of error. As a matter of fact, ambergris is usually found floating at sea, or more generally cast up by the waves on the shore. The fact that it contains the horny beaks of squids and cuttles belonging to species that form the food of the gigantic sperm-whale, or cachalot (by far the largest of the cetaceans furnished with teeth), is alone sufficient to indicate that it is a product of that monster. And from time to time it is actually found in the alimentary canal of that whale. It appears, indeed, to be a biliary concretion, closely analogous in its nature to bezoar stones, and due to the existence of disease in the individuals in which it occurs. In place, therefore, of being found only in old and strong specimens, it is generally at least met with rather in those in poor condition or which have died a natural death. The bags containing ambergris mentioned in Buffon's account would appear to be portions of the whale's intestines which have been cut out and tied up with their contents.

When first taken from the sperm-whale's interior ambergris is a soft, greasy substance, exhaling an exceedingly disagreeable odor; and it is only after exposure to the air that it hardens and acquires its characteristic aroma, which is described as being sweet and earthy. As its name implies, ambergris is of a gray color.

The largest piece of ambergris known to Buffon, as above stated, weighed twenty pounds, but masses largely exceeding this have since been recorded. A piece weighing one hundred and thirty pounds, the value of which was fully five hundred pounds, is, for instance, definitely known, while according to Messrs. Van Beneden and Gervais a mass weighing no less than nine hundred and eighty-two pounds is stated to have been at one time in the possession of the Dutch East India Company. According to information kindly supplied by Messrs. Piesse and Lubin, the average amount of ambergris imported yearly into this country may be put down roughly at one thousand pounds. In a recent trade circular the value of "fine gray" is given as one hundred and twenty-five shillings per ounce, and of "fine black" seventy shillings.

Formerly ambergris found a place in the pharmacopœia, but its sole use at the present day is in perfumery, mainly as a base for other scents of a more delicate nature.

The third substance on our list—musk—is the product of the male musk-deer, or kastura (*Moschus moschiferus*), of the Himalaya and Central Asia, a hornless ruminant of about the size of a small goat. In many respects, such as the possession of a gall-bladder to the liver, this animal approximates to the hollow-horned ruminants, although it is generally regarded as an aberrant member of the deer family. In addition to a rough coat of very coarse and almost pith-like hair common to both sexes, the musk-deer is specially characterized by the presence of a pair of long scimetar-like tusks in the upper jaw of the male, as well as by a peculiar pouch situated in the groin of the same sex, yielding the perfume from which it derives its name.

Although by some writers the name *Moschus* has been derived from μόσχος the Greek for a calf, it really appears to have a totally different origin. For instance, in the dictionary from which one quotation has been already made in an earlier part of the present article, we find the following item:

"MUSK, *n.* [L., *muscus;* Pers., *mashk;* Ar., *musk;* Hind., *mushk, misk;* late Gr., *moschos*, the same as *oschos*, a bag.] A strong-scented substance obtained from a *cyst* or *bag* near the navel of an animal that inhabits the mountains of Central Asia; also, the animal itself. *vt. To perfume with musk.*"

From this it appears that the word musk originally means the bag in which the natural substance is contained. The origin of the name kastura (the first *a* pronounced as the *u* in musk) is less easy to ascertain, but it appears evidently connected with castoreum, the aromatic product of the beaver.

The musk bag, or "pod," is cut out from the animal after death, and when full contains about an ounce of musk. At the time when the rupee was worth two shillings or over, the value of a musk-pod in the Indian bazaars was about one pound sterling. The amount of musk in a pod varies according to season, and the age of the animal; apparently the pods are full only during the pairing-season. When properly taken, the odor of musk is so strong as to cause headache in those by whom it is inhaled. And so enduring is the scent that a piece of musk may be preserved in a room for years, and at the end of that period will be almost as odoriferous as at first.

Messrs. Piesse and Lubin estimate the annual import of musk into England roughly at ten thousand ounces. Several descriptions and qualities are recognized in the trade, as may be seen from the accompanying extract from a recent commercial circular, where the wholesale prices are quoted:

Tonquin Pile I.....	per oz.,	75/- to 80/-
Tonquin Pile III.....	"	32/6 to 50/-
Tonquin grain	"	90/-
Tonquin grain pure.....	"	110/-
Tonquin grain coml.....	"	65/-
Assam grain	"	60/-
Carbardine grain	"	45/-
Nepal grain	"	40/-

In addition to being employed largely in perfumery, musk is also used in the confectionery trade.

Of less importance than either of the preceding in the perfumery trade is *castor*, or *castoreum*, the secretion of the beaver, of which, according to information kindly furnished by the well-known firm of perfumers above mentioned, about one thousand pounds are annually imported into England, at a value of about twenty shillings per pound. Although the use of this scent in perfumery is limited, it is very largely employed in the preparation of Russia leather, to which it communicates the well-known odor.

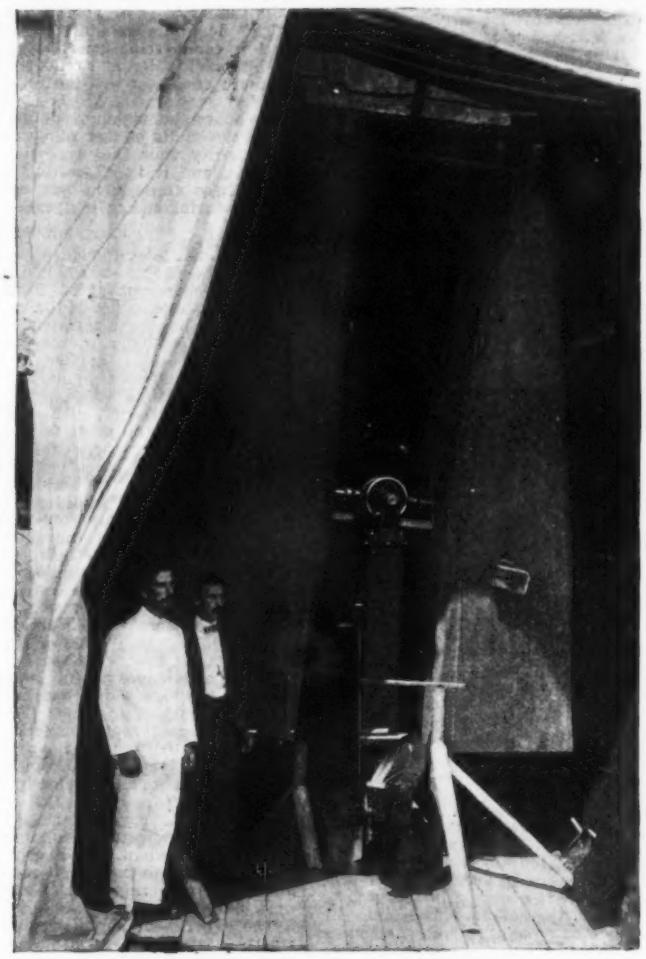
From accounts dating as far back as the year 500 B. C., it appears that beavers were originally hunted for the sake of their castoreum alone, the felting properties of their fur not being discovered till centuries later.

The castoreum is contained in a couple of pouches situated in the groin of the beaver, which when extracted and dried are not unlike two pears; about six pouches going to the pound. In olden times castoreum was regarded as an almost universal panacea, and its value was proportionately high. Although this substance no longer appears in the pharmacopœia, in America, according to the author of Castorologia, "the belief in the miraculous properties of the castoreum is still shared by so many, that the crude article is even now regularly sold in our drug stores, and its value steadily increases, so that quotations of from eight to ten dollars per pound are current for the rough Canadian 'castors' as the pouches are sometimes called, while the Russian article is even more valuable."

It may be added, as a somewhat remarkable circumstance, that the castoreum of the American and Old World beavers differs remarkably in chemical composition, the former containing 58.6 per cent of resin and 2.6 per cent of calcium carbonate, while in the latter we find only 13.8 per cent of the resin and as much as 33.6 per cent of the carbonate. The reason for this extraordinary difference is not easy to suggest.

Two other perfumes of animal origin, namely, "musquash" and "musk-rat," are recognized in the trade, but, according to information communicated by Messrs. Piesse and Lubin, are at the present day of no commercial value, the former being too rank, and the latter too faint. It is a little difficult to trace the origin of these two perfumes, since the "musquash" and "musk-rat" are one and the same animal—*Fiber zibethicus*, a North American relative of the water-vole. Possibly the two kinds of perfume may be taken at different seasons, or may be the product of different sexes.

Yet another substance of animal origin, held in great estimation in the East, both as an antidote to poison and as a remedy against all kinds of disease, may be appropriately noticed in this place. This is the celebrated bezoar, which is commonly believed in Persia to be obtainable only from the wild goats (*Capra hircus ægagrus*) inhabiting the hills between Karman and Shiraz, although it doubtless occurs in those of other districts, and probably also in other species of wild goats or ibex. The name bezoar, according to the late Sir O. B. St. John, is Persian, and should properly be *pa-zahr*, a corruption of *fa-zahr*, which means "useful (for) poison." Bezoar stones are concretions formed in the stomach of certain individuals of the wild goat, and vary considerably in size, shape, and color. A specimen described in Blanford's "Zoology and Geology of Eastern Persia" was egg-shaped, and measured three-quarters of an inch in length; its color being dark olive and the surface highly polished. In Persia bezoars are greatly valued, and in addition to being used as a medicine and as an antidote to poison, are sometimes worn by the women as amulets or charms incased in gold filigree work.



THE INTRAMERCURIAL PLANET APPARATUS OF THE SMITHSONIAN INSTITUTION.

INTRAMERCURIAL PLANET APPARATUS OF THE SMITHSONIAN INSTITUTION.*

IT will be remembered that the solar eclipse of May 28, 1900, was observed by most of the great observatories throughout the world. Among the institutions which sent out expeditions to tropical countries for the purpose of studying the eclipse was the Smithsonian Institution. The apparatus taken along consisted of a camera for the direct photography of the inner corona, together with a 12-inch lens of 125 feet focus used as a horizontal telescope in connection with a cœlostat carrying an 18-inch plane mirror. It was

* From the Annual Report of the Secretary of Smithsonian Institution.

also arranged to use with this lens, just before second contact, an objective prism forming a spectrum upon a plate moved each second by clockwork and thus suited to catch the "flash spectrum," so called. This necessitated a second tube 135 feet long inclined at about 8 degrees to that used for the direct photographs of the corona. Both tubes were made of thick Canton flannel and were 42 inches square with diaphragms of progressively increasing size 10 feet apart. The two tubes were fastened to trestle work covered by long canvas tents. Nearly one thousand yards of canvas and flannel were thus made up. The tube ended in a small photographic house which had been prepared in sections and was transported from Washington to Sumatra. Besides the great horizontal telescope a 5-inch, 38-foot lens was also used for obtaining inner coronal photographs. This lens was mounted upon a pole in such a manner as to be in line with the sun from the eastern window of the photographic house at the moment of totality. A conical tube of white canvas, well blackened within and 36 inches square at its lower end, ran from the house to the lens, but was not attached to the lens or its housing. There being thus no provision for following the apparent motion of the sun with the lens, a suitable motion was given to the photographic plates by means of a clock. With this instrument 11 by 14-inch plates were employed. Upon an instrument which carried the 18-inch mirror of the horizontal telescope was mounted equatorially a 6-inch photographic lens of 7½-inch focus, provided with a conical tube, so that a considerable field was covered. A shade glass, opaque to violet light, was placed over this lens. The purpose of the shade glass was to enable a comparison to be made between the form of the outer corona as photographed with yellow and green light and as photographed with the complete coronal radiations by other lenses.

Within the eastern part of the shed there was mounted upon an improvised polar axis a collection of four cameras well provided as to moving gear by being connected with the very accurate spectro-barometer clock. These cameras were two similar pairs, one with short focus and the other with long focus lenses. The former were two landscape lenses of 4½ inches aperture and 40 inches focus, each provided with a 30-inch square plate. In front of one lens was placed a shade glass opaque to violet light. The two long-focus lenses were of 3 inches aperture of 111 feet focus and resembled those recommended by Harvard College Observatory as most suitable for photographic research for a possible intramercurial planet. The axes of these two cameras were inclined so that together they covered a space east and west of the sun about 12 degrees by 28 degrees in extent. Their fields were found to be so nearly flat as to permit the use of a single plate 24 by 30 inches.

THE UTILITY OF ALKALINE PHOSPHATIC MANURES.

By JOHN HUGHES, F.I.C.

BEFORE considering the subject included under the title of this paper, it will be desirable to briefly refer to the origin and progressive use of

ACID PHOSPHATIC MANURES.

The manufacture of superphosphate in this country may be said to have commenced in 1842, when the late Sir John Bennett Lawes, F.R.S., obtained a patent for treating finely-ground mineral phosphates, such as Cambridge coprolites, with commercial sulphuric acid. The chemical theory then put forth maintained that the agricultural value of phosphatic manures depended upon the extent to which the phosphates they contained were rendered soluble in water through the aid of acid. It was contended that this solubility in water effected the most complete diffusion through the soil that could possibly be obtained, and the theory in itself is still correct, though its application should be restricted to soils containing plenty of lime, so that the acidity of the manure may be immediately absorbed by alkali in the soil. Indeed, at first, sulphuric acid being expensive, it was only used in small proportion, and great caution was observed in the mixing arrangements. Only a portion of the phosphates in the coprolites was rendered soluble in water, amounting perhaps to 20 per cent in the manure produced, and frequently as much as 8 to 10 per cent was left in the form of insoluble or undissolved phosphate of lime. Consequently, in those days, superphosphate was sent out in an excellent dry condition, and this in itself contributed very materially to increase the sale and render the new manure popular among farmers, for there were never any complaints about the damp acid condition of the manure.

When acid, however, became cheaper as the result of improved manufacture from less costly materials, and as competition increased on the expiration of the original patent rights, sulphuric acid was added in greater quantity, and the utmost possible amount of soluble phosphate was obtained, so that only 2 or 3 per cent of phosphate of lime was left in a condition insoluble in water.

Superphosphate then became damper and more acid, so that complaints respecting its bad condition were of frequent occurrence.

Superphosphate when first introduced was chiefly applied as a manure for turnips and swedes raised on good arable land containing sufficient lime, yet there appears to have been some doubt raised in the mind of so keen an observer and experimentalist as the late Dr. Augustus Voelcker, F.R.S., as to whether acid manures were not conducive to disease in these roots.

At any rate, as early as 1863 we find him writing in the Journal of the Royal Agricultural Society upon "Phosphatic Manures for Root Crops" as follows:

"Superphosphate of lime applied to root crops has a different practical effect on different soils.

"Purely mineral superphosphates fail to produce good turnip crops on light sandy soils.

"It has indeed been observed that the exclusive use of superphosphate, however beneficial it may be in the majority of instances, has in some soils led to the complete or partial failure or the presence of disease in the turnip crop.

"No acid combination as such can enter into plants without doing them serious damage; even free vegetable acids, as humic and ulmic acids, are injurious to all crops cultivated for food for the use of man or beast; and unless these acids, which are always present in what practical men call sour humus, are neutralized by lime, or marl, or earth, none but the roughest and most innutritious herbage can be grown.

"Free mineral acids are, I believe, still more injurious to all farm crops, and perhaps to all plants, than the free organic acids that are found in humus.

"A very dilute solution of sulphuric acid—say one part in 1,000 of water—may be used with advantage for killing grass in gravel walks made with flint or quartz sand; after one or two applications, the weeds will be destroyed and will not reappear for a long time. But if the walks are made with limestone gravel, the application of a much stronger acid has little or no effect on the grass or weeds; after some time the latter seem to grow all the better for having had a taste of dilute sulphuric acid. In reality, however, no acid enters these plants, but on coming into contact with the limestone gravel unites with the lime to form that useful fertilizer, sulphate of lime or gypsum.

"These examples thus prove unmistakably that a soil which contains free acid, in ever so small a quantity, is unfit to maintain a healthy growth.

"We have, therefore, strong presumptive evidence that soluble phosphate, a combination which has a strongly acid character, does not as such enter the roots of plants.

"The reconversion of soluble into insoluble phosphate, perhaps may appear undesirable, but in reality, it is not only beneficial, but absolutely necessary to the healthy and luxuriant development both of turnips and all other crops to which superphosphate is applied.

"The more rapidly and completely the soluble phosphate in commercial superphosphates and turnip manures, is precipitated and rendered insoluble in the soil, the more energetic will be its effect upon the turnip crop."

The above statements, made nearly 40 years ago, represent the views of one who was rightly regarded as an authority upon the properties and use of artificial manures, and it is interesting to note the extent to which these views have been realized in actual farm practice during succeeding years.

NEUTRAL PHOSPHATES.

In 1875, the Aberdeenshire experiments with finely-ground phosphates were instituted and conducted under the management of Prof. Jamieson for some years. The publication of the results excited much interest, for they demonstrated by actual field experiments that insoluble, or more properly termed undissolved phosphates, if applied in a finely-ground condition and in sufficient quantity, possessed very considerable fertilizing value, whereas, according to the previously held theory, such raw phosphates were supposed to possess no practical manurial value.

Further, these experiments proved that on certain soils, deficient in lime, ordinary soluble phosphate was not superior in its action as a manure to undissolved phosphates to anything like the extent that had hitherto been generally supposed.

Very naturally these novel results, being opposed to the theory hitherto held, excited a considerable amount of hostile criticism, which, however, time and more extended experience has proved to have been unreasonable and erroneous.

The experiments were carried out at five stations situated in different parts of the county of Aberdeen, and the soils are described in the official report as being "black mould resting upon a granite subsoil," and the analyses show that in every case they were specially deficient in lime. The figures for lime at these five stations were respectively 0.08, 0.17, 0.21, 0.33 and 0.38 per 100 parts of the dry soil.

These soils were in fact exactly those upon which soluble phosphate as supplied by superphosphate would not be likely to exert its full benefit, while the vegetable acids existing in the black mould would naturally dissolve the finely-ground mineral phosphate to a very considerable extent. In short, the conditions were most favorable to the action of undissolved phosphates, and most unfavorable to the action of dissolved or soluble phosphates.

The experiments in themselves, were, however, distinctly useful both scientifically and practically, and Prof. Jamieson will always be favorably associated with what must now be regarded as a step forward in the economical application of finely-ground neutral phosphates.

ALKALINE PHOSPHATE OR BASIC SLAG.

About the year 1883 the now well-known basic slag or Thomas phosphate powder was introduced to the agricultural world. It is the residual slag resulting from the treatment of iron ore by the Thomas-Gilchrist process of adding lime in order to remove the phosphoric acid and silica. Briefly it consists of basic phosphate of lime and basic silicate of lime, associated with some iron, manganese and magnesia compounds.

It has a distinctly alkaline character, but it is a mistake to suppose that this material contains any considerable quantity of free lime, because any such excess of lime would indicate a wasteful method of manufacture, lime being only added in sufficient quantity to remove the phosphorus and silica existing in the original iron ore.

Though but slightly soluble in ordinary water, it dissolves to a certain extent in water impregnated with vegetable acids, and it is the neutralization of such acids which exist in sour grass that largely contributes to make its application so beneficial on certain kinds of soil.

No other manure has ever before occasioned so great a diversity of opinion as to its value as a fertilizer. When finely ground and applied to suitable land with sufficient water either in the soil or from rainfall, the results have been most satisfactory, both in the increased yield and in the improved quality of the grass and hay; but where the conditions are unfavorable and the land unsuitable, the results have been most disappointing. Indeed, when first introduced agricultural chemists of high repute were disinclined to place any fertilizing value on such a hard fused mass, however finely it might be ground, because it was so insoluble in ordinary water.

Little by little, however, farmers were induced to take small quantities for trial, chiefly on old and sour grass lands, and the practical results were so good on certain soils—rich in vegetable acids but poor in lime—that scientific authorities were soon compelled to recognize its value, and as the market price was low the material naturally became popular in certain localities.

In this country the importance of fine grinding has hitherto been recognized as the chief test of the probable manurial value, but in Germany, Prof. Paul Wagner, of the Agricultural Station of Darmstadt, has insisted upon the solubility in a 2 per cent solution of vegetable acid, such as citric acid, as a further and more definite test of probable manurial value.

Dr. Bernard Dyer, in his paper "On the Determination of Probably Available Mineral Plant Food in Soils" (Journal of the Chemical Society, 1894), has adopted a cold 1 per cent solution of citric acid for determining the portions of phosphoric acid and potash existing in a presumably available form in the soil.

The present writer, however, has selected as his standard solvent a 0.10 per cent cold solution, consisting of 1 part of citric acid to 1,000 parts of cold distilled water. Such a solution is twenty times weaker than that of Prof. Wagner, and ten times weaker than that of Dr. Dyer.

In fact, it represents an acidity absolutely below that of the sap of any of the 103 plants, examined by Dr. Dyer in the paper referred to, and it also more closely approximates to the natural acidity of ordinary soils than either of the standard solutions previously employed.

It is therefore contended that any phosphoric acid, lime or potash dissolved out by this standard solution, may be fairly regarded as existing in a form available as plant food, whether in a soil or in a manure.

In the following table the relative solubility in this standard solution of five different kinds of finely-ground raw phosphate, is compared with that of a good specimen of basic slag.

In each case, one gramme of the ground phosphate was exhausted with 1,000 grammes of cold distilled water, in which one gramme of crystallized citric acid had been dissolved.

After standing 24 hours with occasional stirring, the insoluble portion was filtered off, ignited and weighed, while the proportions of lime and phosphoric acid were determined in the clear solution.

MINERAL PHOSPHATES.

Solubility in cold weak solution of Citric Acid (1 *in* 1,000) *after* 24 *hours.*

	French.	Algerian.	Florida.	Tennessee.	Peace River.	Basic Slag.
Total phosphate of lime present...	50.86	55.99	78.26	79.57	61.23	38.97
Fine powder passed through 100 hole sieve....	76.21	67.69	72.37	91 63	93.61	83.80
Portion soluble in citric acid solution.....	30.00	30.00	22.60	22.80	31.40	38.80
Containing—						
Soluble lime.....	15.34	13.66	11.87	11.64	15.23	22.17
Soluble phosphoric acid.....	2.85	6.35	8.25	8.40	9.90	8.70
Equal to phosphate of lime.....	6.22	13.86	18.01	18.34	21.61	18.99

The above results show the percentage of phosphate of lime present in the respective samples, also the fineness of the grinding, the extent to which the respective specimens were dissolved by the cold, weak citric acid solution, and finally, the proportions of lime and phosphoric acid in its equivalent of phosphate of lime existing in the cold citric solution.

It will be seen that ground phosphates are only soluble, and therefore available as plant food to the extent of 22.60 to 31.40 per cent, and that the basic slag is only dissolved to the extent of 38.80 per cent, in fact only a little more than one-third of its weight, though it was of good quality, 38.97 phosphate of lime and 83.80 fineness.

As regards the actual amount of phosphate of lime dissolved out of the five specimens, the Peace River, with a fineness of 93.61, gave the highest figures for solubility, there being 21.61 phosphate of lime dissolved out of a total of 61.23.

In the case of basic slag, the figures, though relatively higher, are actually less, namely, 18.99 phosphate of lime dissolved out of a total of 38.97. These results explain why Prof. Jamieson, with the black vegetable mould to experiment upon, obtained an appreciable increase in the yield of turnips from the application of finely ground raw phosphates, though if we take the most favorable example, namely, Peace River, only about one-third of the total phosphates would have been utilized as available plant food and the remaining two-thirds was of no use to the crop.

The defect in the economical application of finely-ground phosphates is their insufficient solubility, and it is this want of solubility that is the defect also of basic slag when applied to many soils.

Before leaving these figures it is interesting to notice that it is only in the proportion of soluble lime that basic slag shows a superiority over that of Peace River phosphate, there being 22.17 per cent dissolved out as against 15.23.

Indeed, the fertilizing value of ordinary basic slag must be ascribed as very largely due to the ready supply of lime when the slag is brought in contact with sour soil, if accompanied by plenty of water either in the soil or from the rainfall.

It is well known that slag fails to produce any practical results on certain soils, and this failure is probably due partly to a deficient supply of water and partly to the absence of that excess of vegetable matter which is necessary to produce an acid solvent.

THE NEW MANURE BASIC SUPERPHOSPHATE.

It occurred, therefore, to the author, after careful consideration in the autumn of 1900, that a new and useful manure could be produced by the careful admixture of suitable proportions of ordinary acid superphosphate with finely ground or slaked lime.

After making numerous trial mixtures the most suitable proportions were decided upon, and a manure was produced which possessed a distinctly alkaline or

basic character, and at the same time supplied from 25 to 27 per cent of phosphate of lime in a form readily soluble in the standard solution (1 in 1,000) of citric acid.

The manure so produced was appropriately called basic superphosphate because it combined the alkaline nature of slag with the well-known solubility of superphosphate.

The mechanical condition is superior both to that of basic slag and superphosphate. Compared with the former it is much more bulky and lighter in weight, so that if equal weights be placed in two glass tubes about 1 foot long basic superphosphate will be found to occupy a space of 11 inches as compared with only 4½ inches occupied by basic slag, the relation in round numbers being as 100 to 40.

Compared with superphosphate the new material is very much drier, containing only 4 to 5 per cent of moisture instead of the 14 to 18 per cent usually found in commercial superphosphate.

Being in a finely ground dry powder of light weight and bulky nature, greater uniformity and more perfect distribution can be obtained than is possible with basic slag, which when sown by hand is apt to drop between the fingers before complete delivery can be effected.

Farmers will appreciate these advantages, and will be glad to be assured that there will be no danger of any clogging of the drill from damp condition, which in the case of badly made superphosphate is a very serious defect, and renders the uniform distribution of the manure quite impossible.

The general composition of basic superphosphate may be gathered from the following analysis:

COMPOSITION OF BASIC SUPERPHOSPHATE.

Moisture (lost at 212 deg. F.)	4.15
Combined water and loss on ignition	12.86
*Phosphoric acid (total)	13.60
Lime	35.15
Sulphuric acid	28.50
Oxides of iron, alumina, magnesia, etc.	2.34
Insoluble siliceous matters	3.40
	100.00
*Equal to phosphate of lime	29.68

The manure usually contains from 33 to 35 per cent of total lime, so that in this respect basic superphosphate supplies fully 10 per cent more lime than ordinary acid superphosphate.

The superior solubility in cold water of basic superphosphate compared with good basic slag, containing 38.97 phosphate of lime and 83.80 fineness, is shown in the following table:

Solubility in Cold Water after 48 Hours, 1 Part Manure to 1,000 Parts Cold Water.

	Basic Super.	Basic Slag.
*Portion soluble in cold water	66.80	6.60
Portion insoluble (after ignition)	33.20	93.40
	100.00	100.00
*Containing—		
Soluble lime	22.28	4.70
Phosphate of lime	None	None

It will be seen that basic superphosphate is fully ten times more soluble in perfectly cold water than well ground basic slag, the figures being 66.80 against 6.60 per cent. Further, that there is 22.28 lime dissolved out in the former against only 4.80 in the latter.

These figures may, perhaps, explain why basic slag fails on certain soils, while it produces excellent results upon others. It is not ordinary water that is capable of decomposing a hard fused mass like slag, however finely it may be ground, but water impregnated with vegetable acids. In other words, it is only on sour acid soil that special benefit may be expected from the application of slag.

It will be noticed that no phosphate of lime was dissolved out by plain water from either manure, because on account of the presence of lime in excess, all the phosphate of lime was retained in a precipitated form in the basic super, and in a more insoluble form in the slag.

Solubility in (1 *in* 1,000) *Citric Acid Solution* (1 *part Manure to* 1,000 *parts Solution*) *after* 24 *hours.*

	Basic Super.	Basic Slag.
*Portion soluble in citric solution	94.20	38.80
Portion insoluble (after ignition)	5.80	51.20
	100.00	100.00
*Containing—		
Soluble lime	34.73	22.17
Soluble phosphoric acid	12.45	8.70
Equal to phosphate of lime	27.18	18.99

The above figures show that when both manures were treated in exactly the same manner, in regard to the quantity and strength of citric acid solution, with the same time allowed in each case for exhaustion with the standard solvent, basic super was dissolved to the extent of 94.20 per cent, as against 38.80 per cent in the case of the basic slag. Further, 34.73 lime was dissolved in the former, against 22.17 in the latter. Lastly, 27.18 phosphate of lime was dissolved out of the basic super, against 18.99 out of the slag. The slag employed was the same as was used in all the previous experiments, and was of good quality and well ground. Though the slag contained 38.97 total phosphate of lime, only 18.99, or less than half, was dissolved by the standard solvent, and may therefore be considered to represent the proportion probably available as plant food.

It is very important to bear these figures in mind, and to remember that it is not the total amount of phosphate of lime present in slag that should be regarded as indicative of its manurial value, but the actual quantity that is likely to be available as plant food.

Hence, as a quick-acting manure, suitable for late application in the spring, basic super must be regarded as far superior in fertilizing effect to ordinary slag, notwithstanding the high total contents of phosphate of lime contained by the latter.

THE UTILITY OF THE NEW MANURE.

Basic superphosphate can be applied, indeed has been applied in the season of 1901, with great advantage on soils deficient in lime, such as sand, gravel, granite, peat and clay.

Briefly, it may be stated that all soils containing less than 1 per cent of lime will be greatly benefited by the application of basic superphosphate instead of slag or ordinary superphosphate.

It is of practical importance to state that though originally invented to supplement the deficient solubility of slag, which is fully recognized by those interested in its sale (they therefore recommend its application during the winter months), it has been found by actual field results that the new manure is superior also to superphosphate on soils deficient in lime.

Mr. William E. Bear, of Magham Down, Hailsham, employing equal quantities of basic super and ordinary superphosphate, was able to obtain a growth of radishes, 66 per cent greater in weight by the use of the former manure, than he did by the latter.

In this case the soil contained, according to Dr. Bernard Dyer's analysis, only 0.68 of lime per cent in the dry state.

In another experiment on the farm of Mr. Ouston, near Grimsby, in Yorkshire, basic super used at the rate of 5 cwt. per acre, gave a specially good crop, and the soil on analysis was found to contain only 0.78 of lime per cent.

Mr. Edward Packard, at Saxmundham, obtained by the application of 5 cwt. of basic super per acre, 18¾ tons of swedes, against 15 tons produced by 5 cwt. of slag, and 14¼ tons from the no manure plot, the soil in this case containing 1.75 lime per cent.

It is well known that soils subject to the disease known as finger and toe in turnips, are naturally deficient in lime, containing in fact considerably less than 1 per cent, and on such soils it is reasonable to suppose that an alkaline phosphate manure would naturally be a more suitable dressing than an acid phosphate manure such as superphosphate.

During the season of 1901 numerous instances were recorded in which basic super has been used on such soils with very marked advantage, the virulence of the disease being materially reduced, and in some remarkable cases in Scotland, its application has completely prevented any attack, while other parts of the field manured with ordinary superphosphate had suffered very much from the disease.

In connection with this subject, it may be convenient to point out by means of the following tabulated figures, the relation in which lime and phosphoric acid are respectively removed from the soil by ordinary farm crops.

LIME AND PHOSPHORIC ACID REMOVED PER ACRE BY FARM CROPS.

	Lime, Pounds.		Phosphoric acid, Pounds.	
Clover hay, 2 tons	86		25	
Turnips, root, 17 tons	35.5	74	22.5	33
" leaf	48.5		10.5	
Mangels, root, 22 tons	24.0	53	34.0	49
" leaf	29.0		15.0	
Swedes, root, 14 tons	19.5	42	17.0	22
" leaf	22.5		5.0	
Beans, grain, 30 bushels	3.0	33	22.5	32
" straw	30.0		9.5	
Meadow hay, 1½ tons	28		13	
Potatoes, tuber, 6 tons	3.0	26	24.0	27
" haulm	23.0		3.0	
Oats, grain, 45 bushels	2.0	12	12.0	19
" straw	10.0		7.0	
Wheat, grain, 30 bushels	1.0	11	14.5	23
" straw	10.0		8.5	
Barley, grain, 40 bushels	1.5	10	15.0	20
" straw	8.5		5.0	

It will be seen that in respect of an average crop of clover, hay, turnips, mangels, and swedes, lime is relatively required in greater proportion than phosphoric acid. It is useless, therefore, to expect to grow good crops, or crops free from certain diseases, if there is a deficiency of lime.

On the other hand, it would appear that wheat, barley and oats require phosphoric acid in greater proportion than lime, though the actual quantities are much less than in the case of root crops or clover hay.

This table of figures is also useful in illustrating the great waste of applying lime in large quantities, such as 3 or 4 tons per acre, for the actual crop requirements would appear to be less than 100 pounds per acre.

If 2 or 3 hundredweight of superphosphate are considered sufficient to supply the requisite quantity of phosphoric acid, surely 3 or 4 hundredweight of lime should be sufficient to supply the requisite quantity of lime.

Of course this remark only applies to the application of lime to ordinary well-drained soil, and not to damp sour grass land where the natural acidity of the soil would require larger dressings of lime.

But under ordinary conditions large dressings of lime are practically wasted because the slaked lime, which is not absorbed by the soil or the plant, rapidly becomes converted into carbonate of lime, in which form it is but little soluble in ordinary water.

Usually where the soil is deficient in lime, the cost of its application is very great by reason of carriage from a distance, and in all such cases basic superphosphate will be found particularly useful and decidedly economical, because in addition to supplying from 25 to 27 per cent of phosphate of lime in a form sufficiently soluble to afford available plant food, it also supplies an appreciable dressing of caustic lime.

How beneficial small dressings of alkaline ashes are may be inferred from the practice in India of burning the stubbles after the removal of the corn and previous to the usual rainfall.

In this country the custom of collecting and burning the common couch grass (*Triticum Repens*) is to be highly commended as being not only the most effectual way of eradicating this troublesome weed, but as being a cheap means of supplying valuable alkaline ashes to the soil; for these ashes materially assist that important bacterial action whereby the inert vegetable matter of the soil is converted into valuable fertilizing compounds such as nitrates.

A strong argument in favor of the utility of alkaline phosphatic manures is afforded by the fact that all the natural manures hitherto used in agriculture are distinctly alkaline. Thus, farmyard manure, in the efficacy of which farmers thoroughly believe, is alkaline, and its agricultural value depends upon the extent to which the nitrogen compounds are converted by proper fermentation into ammonia salts. Guano, especially the good old Chincha Peruvian quality, is thoroughly ammoniacal.

Bone dust, dried blood, woolen waste and shoddy, also soot, and lastly lime, are all more or less alkaline in their nature, and certainly not acid.

Moreover, it is hardly necessary to repeat that basic slag is itself a striking instance of the utility of alkaline phosphate of lime as a manure for certain soils.

Indeed it is not natural that manures should be acid, and the reason why ordinary acid superphosphate has been beneficial to crops grown on good arable land, is that the acidity of the manure has been absorbed or neutralized by the abundance of lime usually present in such soils.

Obviously, where the soil is deficient in lime the acidity of superphosphate cannot be immediately absorbed, and harm may be done to the young rootlets of the plant.

It would require a very heavy dressing of lime to saturate the soil so completely that every square inch of surface should always contain the necessary quantity of lime requisite to absorb the acid from every particle of manure that may be brought in contact with it. In other words, it is much more economical to add lime in small quantity to the manure for the purpose of immediate and complete neutralization, than to add lime in large quantities and at long intervals to the soil in order to provide a wasteful excess of alkali for the absorption of a minute quantity of acid.

The necessity of relying upon a sufficiency of lime in the soil is entirely removed when using basic superphosphate, as by the careful admixture of an excess of lime in its manufacture all acidity is removed and the manure may be applied, mixed directly with the seed without danger of destroying the vitality of the same.

As a practical demonstration of the injurious effects produced by the continued annual application of acid salts, it is only necessary to refer to the report on the Woburn experiments by Dr. Voelcker in the last number of the Journal of the Royal Agricultural Society, in which a photograph is given of absolutely barren spots where the barley crop had entirely failed in consequence of the annual application of sulphate of ammonia to a ferruginous sandy soil. These barren spots were evidently due to the local accumulation of acid compounds and the absence of sufficient lime, for on the adjoining plot, which had received the same quantity of ammonia salts annually, but had in addition received a dressing of lime, the barley was looking thoroughly healthy.

On such soils as that at Woburn, basic super, which, in addition to phosphates, supplies some caustic lime, will naturally be more suitable than ordinary super, and when it is remembered that four-fifths of the former consists of ordinary superphosphate, the manufacturer will find it to his interest to supply the new manure. Indeed, on all light sandy ferruginous soils manufacturers are at present in an awkward position, because acid manures being unsuitable it follows that an alkaline manure, superior in its fertilizing properties to basic slag, should be supplied, as otherwise no practical opposition to the use of slag is available.

Basic superphosphate has the advantage that it can be mixed with nitrate of soda without any fear that the valuable nitric acid will be decomposed or driven off by an excess of acid, and the resulting compound is in an excellent dry powdery condition, admirably adapted to secure uniform distribution as a top dressing.

During the season 1901, the manure has been sold in 187 places in England, 72 in Scotland, and 13 in Ireland. Many of the deliveries so included were in quantities of 10 to 20 tons, consigned to agents, so that the actual local trials have been still more numerous.

The practical results obtained in the field have, notwithstanding the dry season, been most encouraging, and have fully realized the favorable opinion originally formed from the analytical results.

CONCLUSION.

In conclusion, it should be mentioned that basic superphosphate is not intended to supersede ordinary acid superphosphate upon soils containing plenty of lime, nor is it intended to take the place of well ground slag for application to damp sour land; but it is rather intended to take an intermediate position between these two well-known and most useful manures, and to be employed as a quick acting alkaline phosphate manure, specially useful as a spring dressing for crops grown upon soils that contain less than 1 per cent of lime, the united acreage of which represents such a large area of the cultivated land in the United Kingdom.

The utility of alkaline phosphate manures when applied to certain soils has already been practically demonstrated by the great success that has attended the use of basic slag, notwithstanding its slow solubility, its frequently defective grinding, and recently, its reduced percentage of phosphate.

If therefore a material of similar alkalinity, but of greatly superior solubility, can be obtained in an unlimited quantity, and of uniform quality, it is reasonable to anticipate that basic superphosphate will prove to be a really useful and most valuable additional fertilizer.

The time has come when manures should be adapted to the soil, rather than that the soil should adapt itself to the manure.

Obviously, soils differing so much in their chemical composition and physical character, as chalk and clay, peat and sand, granite and gravel, require different

manures, in the same way as they require different cultivation and different kinds of crops.

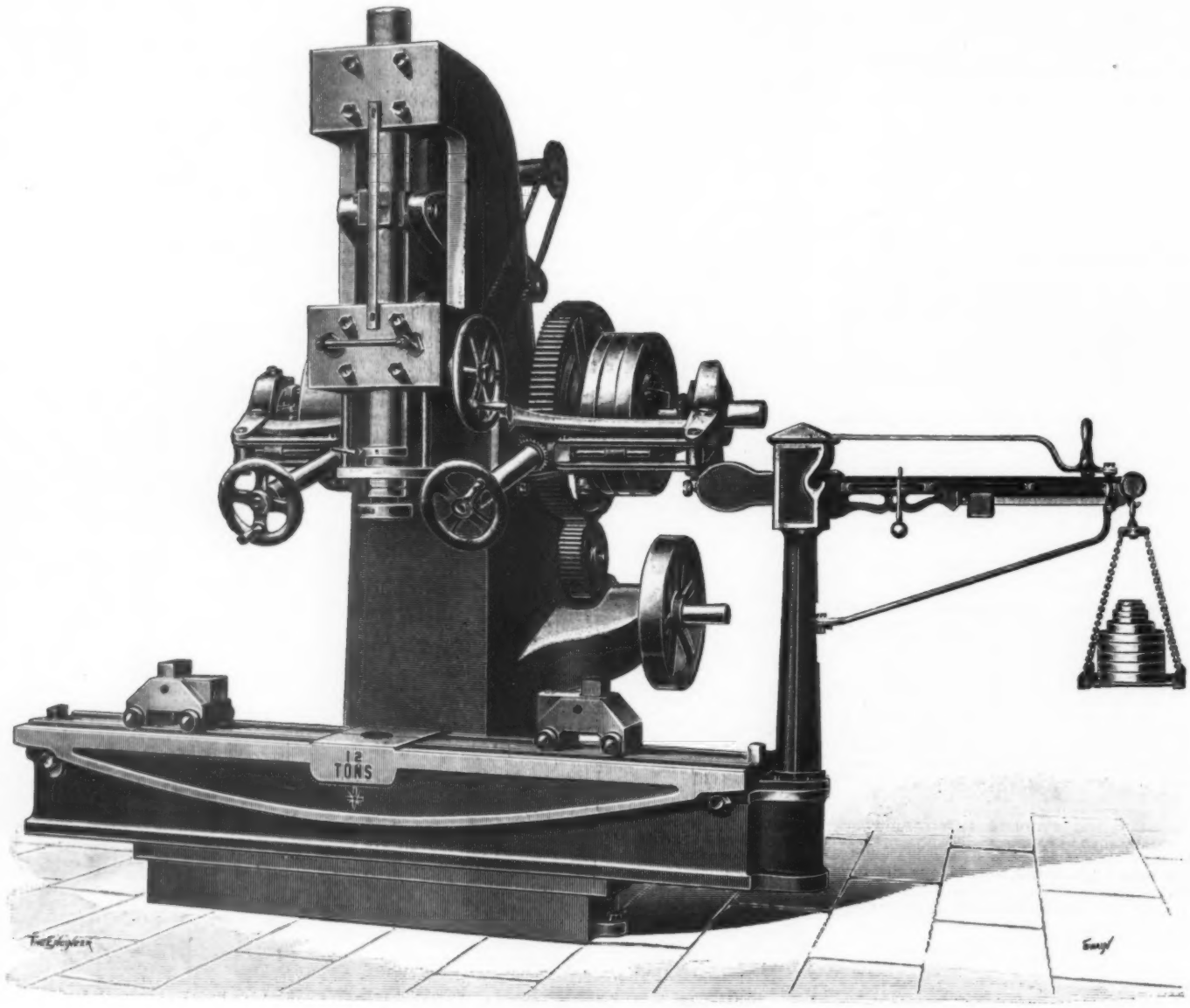
It is not scientific, it is not economical, and it cannot be to the advantage of the farmer, that one kind of manure should be sold for application to all kinds of soils.

Acid manures may with advantage be applied where there is plenty of lime, and alkaline manures may be more profitably applied where lime is deficient.

SOME LOCOMOTIVE SHOP TOOLS.

THE engraving shows a spring testing machine, made by Joshua Buckton & Co., of Leeds, which will not only weigh and measure the deflection of the spring, but will give it a rapid action such as it would encounter in running on a permanent way, and will then exactly weigh and measure the falling off in the spring if there should be any. It is designed to test laminated springs, helical springs, and volute springs up to 12 tons pressure, up to 7 feet 6 inches long and 1 foot 4 inches high. The maximum stroke is 15 inches, variable down to 3 inches, and the ram can be driven either at ten strokes a minute for accurately calibrating the resilience of the springs, or at 150 strokes per minute for testing the power of the springs to withstand rapid vibrations. The end of the ram is fitted with a screw adjustment to suit varying heights of springs. The pressure from the ram is arranged to act upon the springs through the same pin holes, which the weight of the rolling stock bears upon in actual running, so that buckles, eyelets, and other attachments are tested at the same time as the spring itself. When the machine is testing the springs with its rapid action the springs are made to vibrate through a range of 3 inches or 4 inches without the removal of the load, so that the spring and all its attachments are acted upon with the same violence as they would encounter if running at sixty miles an hour over 30-foot rails with imperfect joints. This machine is in use at the works of the Taff Vale Railway, Cardiff.

A radial drilling machine for boiler work is shown in another engraving. The special advantage of this machine is that it will drill two holes at a time at any distance from each other between 7 inches and 5 feet. The headstocks carrying the drill spindles have a motion of 14 inches at right angles to the main jib of the machine—an exceptional arrangement which may be readily overlooked in the engraving. This enables lines of parallel holes to be drilled without swinging the main jib. The spindles are reversible for tapping, and all the handles controlling the machine are near the end of the jib. For drilling locomotive fireboxes a special swiveling table is used in conjunction with this machine. There is a pit at the back of the main table, which can be swiveled until it is in a vertical plane like the face plate of a lathe, or in a horizontal plane. The table itself has a circular motion, controlled by a worm and worm wheel, so that all four sides of a locomotive fire-box can be drilled at one setting of the table. Holes, in fact, at any angle whatever can be drilled in the work while the spindles of the machine remain vertical.—The Engineer.



TAFF VALE RAILWAY—SPRING TESTING MACHINE.

REPORT ON THE METRIC SYSTEM.

THE report of the committee on the bill providing for the adoption of the metric system by the government of the United States has been completed. The report advocates the reforming of our systems of measurements.

A complete statement of the weights and measures in common use would not only be difficult to make, but would involve more space than is available in a brief report. It is sufficient to state, however, that the various units have been inherited from a time when exact measurements were unheard of, computations were seldom made, and when each locality and different interest had its own system of measures. Modifications and adjustments have been made from time to time; nevertheless, the system is full of inconsistent ratios, the units are not related to each other, many units of the same name have different values, it is unsuitable for computation and is not decimal in character. This last defect has sometimes been urged in its favor, but it is difficult to comprehend how anyone familiar with the subject should advocate any other than a decimal system of weights and measures in connection with a decimal system of numbers. It may be true that a system of weights and measures in which a binary subdivision is followed might be better in a few instances, but, on the whole, experience has shown that the advantages to be gained by a decimal system far outweigh those of any other. However, it should be noted that a binary system of subdivision is but seldom followed in our common system of weights and measures, and further that a decimal system is capable of this method of subdivision, as illustrated by the use of halves and quarters in the metric system of measures and in all decimal systems of money.

It is a popular fallacy that our weights and measures are in accord with those of Great Britain, but this is not true, as neither our pound, the yard, the gallon nor bushel are identical.

Very few people are familiar with the weights and measures in common use in the United States. One has but to recall the tables of our three different systems of weight, the apothecary, the troy and the avoirdupois, to illustrate this fact. And while the yard may be stated as our standard of length, we find in practice various arbitrary multiples of the yard and foot; for example, the fathom, the surveyors' and engineers' chains, the nautical and statute miles, hands, poles, perches and various others. In addition to the ordinary cubic measure we find three systems of measuring capacity: dry measure, liquid measure and apothecary's fluid measure. To these might be added a large number of technical standards in use in the various trades and industries, which would be greatly simplified and unified upon the adoption of the international system of weights and measures. An examination of the common tables of weights and measures discloses the fact that there are 64 different ratios used, of which 19 are not divisible by two, and that there are 18 terms used which have two or more meanings. Certainly any effort on the part of Congress to replace this conglomerate system with a simple, logical one similar to our monetary system is worthy of the consideration of Congress.

The metric system of weights and measures was devised as an international system. The fact that it was first adopted by France has given rise to the custom of referring to it as the French system. It is interesting to note, however, that one of the first to propose a decimal system of weights and measures was James Watt, the inventor of the steam engine, and the adoption of a decimal system of coinage by the United States was one of the strongest influences leading to its adoption. As originally proposed the unit of length in the metric system was called the meter and defined as the one ten-millionth part of the distance from the equator to the pole of the earth measured on a meridian. The first of these units to be constructed was by the French government and was based upon the best known measurements of the earth's surface at that time. Subsequently more accurate measurements of the earth's surface showed that the meter as first constructed was not of the length intended nor was its material or form such as required by modern refined measurements.

To remedy this defect an international congress was held in Paris, 1875, 17 different nations participating. It was thought best to retain the length of the old meter. Accordingly a number of copies were constructed of the best material and method of construction known to science. One of these was selected as the international meter and is very carefully preserved at the International Bureau of Weights and Measures, established and maintained by the countries participating in the congress and those which joined the convention later. These meters were very carefully compared with the one selected as the inter-

national standard and then distributed to the countries interested.

The unit of mass (weight, as it is commonly called) in the metric system is called the kilogramme, and is defined as the mass of a cube of pure water, the length of the edge of which is one-tenth of a meter. While this definition establishes the relation between the unit of length and the unit of mass, water is not suited for a material working standard, hence the international committee at the time of the preparation of the meter also prepared 40 pieces of metal equal in mass to that of the cubic decimeter of water, and alike in form and of the same material as the standard meter, the most permanent metal known. One of these was retained at the International Bureau of Weights and Measures as the international kilogramme. The same precautions were observed in the comparisons with each other and with the one selected as the international standard before distributing them to the respective governments. Of the two meters and two kilogrammes sent to the United States one of each is preserved as the national standard of length and mass, the others are taken as working standards and serve as the basis of all comparisons of length and mass in this country. The fact that the meter is not a natural standard as originally intended has sometimes been used as an argument against the metric system. This, however, is of little importance, since the meter and the kilogramme as constructed are as permanent as it is possible to make material standards, and if at any time a suitable natural standard should be discovered the meter would simply be defined in terms of that standard as was originally proposed of the earth's quadrant.

The advantages of the metric system may be briefly stated as its decimal character throughout, the simple relation between the units making it possible to derive all others directly from the unit of length; its elasticity, being equally convenient for the measurement of the smallest or largest objects. These advantages have been proven by a century of use, but that which especially commends it to us at the present time is its international character, since it is the opinion of all who are in a position to know that the world must soon come to an international system of weights and measures, and there is not the slightest possibility of our own system or any modification of it becoming universal.

THE METRIC SYSTEM AS USED IN SCIENTIFIC WORK.

Scientific investigators early recognized in the metric system of weights and measures a simple, flexible system equally suitable for the most refined or coarsest measurements or for purposes of computation. As a result the scientific world to-day enjoys the advantages of a universal system of weights and measures, a fact which has greatly facilitated the development and spread of scientific knowledge. The practical applications of scientific work have in many cases been seriously handicapped or retarded, owing to the necessity of converting formulæ derived in the metric system to equivalent formulæ in the common system. If the formulæ and other data used in manufacturing and engineering were universally expressed in the metric system it would greatly promote the growth and dissemination of such knowledge throughout the entire world.

The benefits to be derived from the adoption of the metric system by the educational interests of the country are, perhaps, the most important that have been brought to the attention of this committee. Estimates made by the Department of Education and others show that the work of at least two-thirds of a year in the life of every child would be saved by the adoption of the metric arithmetic. The British Parliamentary Committee having in charge a similar investigation estimated the saving in time at one year. This is a matter the importance of which can hardly be overestimated, taking into consideration the large amount of work to be covered in the curriculum of the schools and the enormous sums annually devoted to educational work. The metric system is taught in nearly every school in the country. Teachers and pupils alike unanimously testify as to the ease with which the system is taught and learned and the facility with which it is applied to the problems which in ordinary arithmetic are complex and difficult to solve.

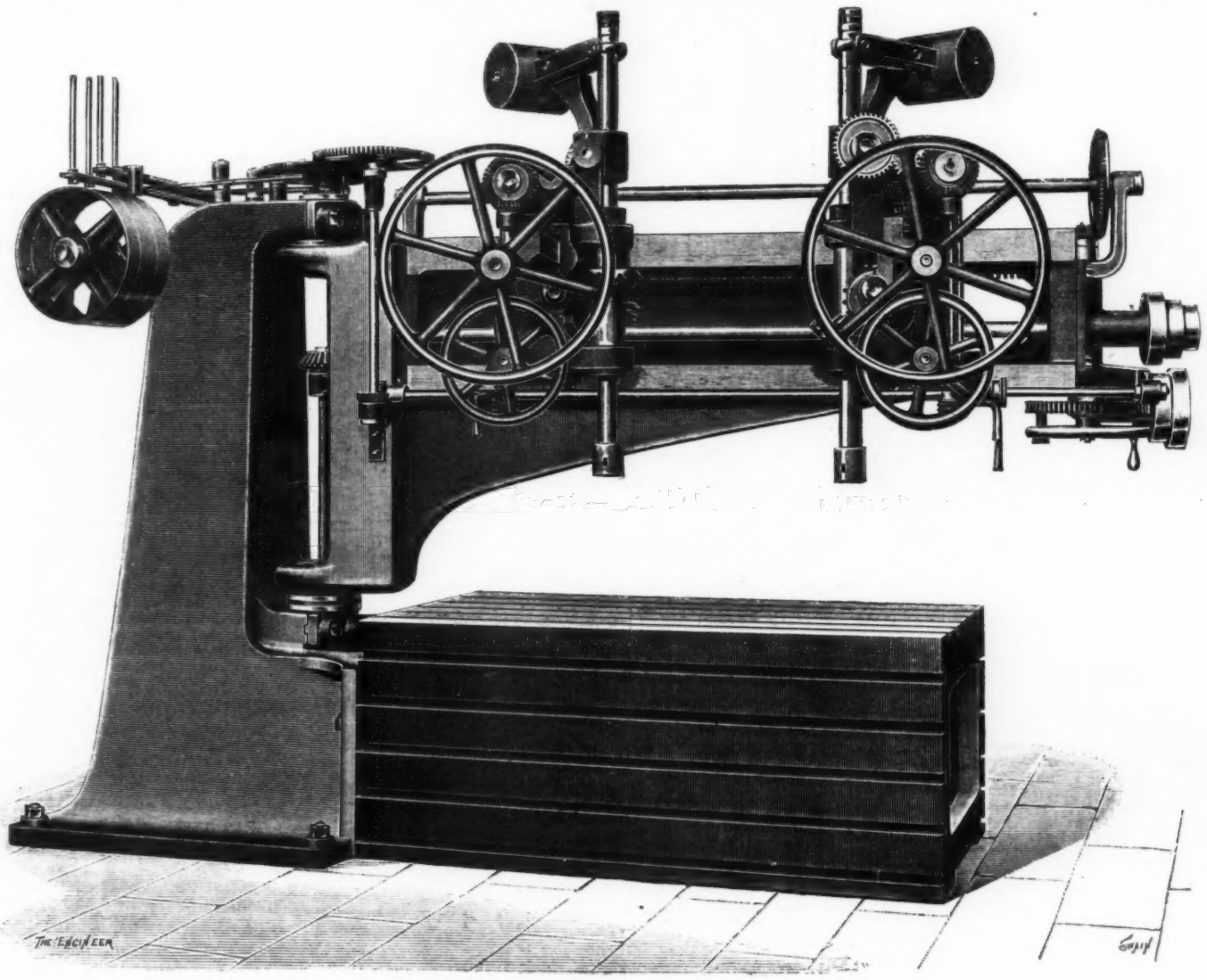
In higher education the metric system of weights and measures is used almost exclusively, and attention is called to the action of the Associated Academic Principals' Association of the State of New York, a body of some 700 high school principals, superintendents and prominent educators, which has passed the following resolution in regard to the adoption of the metric system: "Resolved, That we hereby instruct the Legislative Committee to forward to Congress of the United States, if there shall be suitable occasion and opportunity, our earnest petition for the enactment of such legislation as shall render the use of the metric system obligatory throughout the United States." Many similar actions by educational bodies of all kinds throughout the country have been called to our attention.

It is a matter of evidence on the part of educators of the United States, Great Britain and Continental Europe that the metric system and its application to the solution of problems may be learned in one-tenth the time required for gaining an equal facility in the use of the English system of weights and measures. The question might well be raised whether any measure of more vital importance and benefit to the educational interests of the country has ever come before Congress.

The necessity for an improvement in the weights and measures of the country is nowhere more apparent than in the ordinary business transactions of daily life. Grain and produce are bought and sold by capacity measure—the bushel, peck and quart. The necessity for handling these commodities in large quantities by weight has resulted in the adoption of different weights for a bushel for the same commodity in different parts of the Union, and in a few of the Western States the hundredweight is used instead of the bushel. The diversity in this respect is so great that a correct table of the number of pounds to the bushel of different commodities for the several States is difficult to procure.

Both the long and short ton, without any distinction in name, are used in the buying, selling and transportation of coal, ore, metals and other heavy products. For liquids in large quantity the barrel used has many different values, and we find in common use, often side by side, avoirdupois weights, troy weights, apothecary weights and the weights of the metric system. To add to this confusion the subdivisions of the ordinary measures are often not adhered to, the engineers using feet and tenths of a foot, instead of feet and inches; the manufacturer, inches and decimals of an inch, instead of adhering to the binary subdivision; and even the gager uses gallons and tenths of a gallon.

In the customs service duties are levied in yards and tenths of a yard, and in the handling of bullion we find troy ounces and thousandths of an ounce, instead of ounces and grains. The engineer has discarded the inch, while some manufacturers of machinery have discarded the foot; hence we find the tenth of a foot and the inch in common use. These are but a few of the instances where the introduction of the metric system would not only afford the advantages of a decimal system, but a system sufficiently elastic for all purposes. The experience of other nations has shown that the confusion and inconvenience caused by a change in the measures used in daily life were largely overestimated, and in no case have the people expressed a desire to return to the former system of weights and measures.



TWO-SPINDLE RADIAL DRILLING MACHINE.

The enormous development of the commerce of the United States within recent years has brought to the attention of our merchants and business men the great advantages to be derived from the adoption of the international system of weights and measures. The use of the old system not only involves great loss of time in making computations, but places our merchants at a great disadvantage in dealing with countries which have already adopted the international system. More than 60 per cent of our commerce is now carried on with countries using the metric system, and it is evident that the commerce of the world must soon conform to the metric basis. Theodore C. Search, president of the National Association of Manufacturers, states as follows:

"Wherever manufacturers undertake to extend their trade in foreign countries they encounter the metric system, and it is the only system of absolute uniformity which prevails throughout the world. The pound, the quart, the gallon, the ton, have varying values wherever encountered in foreign countries, and to insure accuracy the use of these units requires further explanation and some qualifying description in order to indicate just what quantity is meant. The enormous growth of our export trade during the past four years has brought our manufacturers in touch with the outer world as never before, and has given very practical illustration of the cumbersome character of our meth-

ods of measurement and the advantages to be derived from the adoption of a system which is absolute and uniform throughout the world."

As we have only just entered upon a commercial conquest of the world, the utility of the metric system will become more and more apparent and the necessity for its adoption more urgent with each year of our growing export trade. The extension of our governmental functions to the Philippines, Cuba and Porto Rico brings into the circle of our commercial operations millions of people to whom the metric system is the recognized standard, and to whom our own cumbersome systems of weights and measures are a strange and unknown language of trade.

We recognize that any effort to supplant our present system of weights and measures with the metric system will be attended with more or less difficulty, and will involve a great deal of trouble for many of our manufacturers, because of the necessity of changing drawings, patterns and standards, but we believe it entirely possible to accomplish such a change by gradual steps, and there should be no necessity for causing loss or injury to any of our industrial interests. It seems to your committee that every argument is in favor of the unification of standards of weights and measurements throughout the world, and for us to insist upon an adherence to our own antiquated standard is not in accord with the progressive nature of our people and the progressive tendency of this age.

W. P. Wilson, director of the Philadelphia Commercial Museum, states his belief that "millions of dollars are lost every year in transposing our weights, measures and money from that of one country to another in our international business relations." The testimony of Godfrey L. Cabot, a prominent merchant of Boston, includes the following statement: "Wherever this great improvement has gone it has simplified the ordinary commercial transactions of daily life, minimized disputes, and given an absolute standard from which there could be no appeal and in which there was the least possible danger of error or misunderstanding."

METRIC SYSTEM IN MANUFACTURING.

Any change in the standards employed in manufacturing, no matter how perfect the system proposed or how beneficial the change may be, must be very carefully and judiciously made. In the case of textile fabrics, materials of construction, package goods and almost all kinds of manufactured products, a change would no doubt involve some inconvenience, but the expense of modifying existing plants or machinery would be very slight, as compared with the cost of the machinery, and in many cases no change or expense is necessary; and the benefits to be derived from a convenient and universal standard would far more than compensate for the expense and confusion temporarily involved during the transition stage. The relation between the manufacture and sale of these products is so close that any change in the system of weights and measures which will lessen the burden and expense of the counting room and office is worth the cost considered from the standpoint of economy alone. The action of many associations of manufacturers and merchants, both in the United States and Great Britain, has been called to our attention, and without exception they have urged the adoption of the metric system of weights and measures, on account of its international character and superiority over the present system for manufacturing and commercial purposes.

In no other country has the construction of machinery reached a degree of perfection superior to that of our own, a result principally due to the system of interchangeable parts. The latter may be said to be a product of American ingenuity, and to be the greatest single advance in modern machinery, and it has for its essential features a uniform standard of length and accurate length measuring instruments. This work has been done upon the basis of an inch which in many cases has been decimalized.

There are a few who claim that the inch is better suited for this purpose than the units of the metric system. However, it should be kept in mind that the interchangeable system does not depend upon the unit used, but upon uniform, reliable standards and accurate measurements, and it is difficult to see why the inch and fractions of an inch should be superior to the centimeter and decimals of a centimeter or millimeter and decimals of a millimeter, or why German, French, English and American manufacturers who are successfully manufacturing upon a metric basis, in but few instances, even in the case of the American and English manufacturers, have shown any desire to return to the old system, notwithstanding the fact that the change has been made in the latter case under very adverse circumstances.

It is admitted that the temporary inconvenience caused in the shop and drafting room by the proposed change would be very serious if suddenly brought about, but any measure which contemplates only the gradual introduction of the one system for the other, or even the continuation of the old in case it is desired, cannot be said to be compulsory or capable of producing more than a minimum of inconvenience or expense, and certainly an interchangeable system upon an international basis will be far superior to that of a single country alone.

A CAT'S GREAT JUMP.

A CARD attached to a stuffed cat in the Smithsonian Institution at Washington tells a remarkable story:

Many years ago, while the Washington Monument was still in an unfinished condition, an adventurous and patriotic cat ascended the interior of the shaft by means of the ropes and scaffolding. When the workmen arrived at the upper landing the next morning and began to prepare for the day's work, the cat took fright, and, springing to the outer edge, took the leap of one hundred and sixty feet to the hard earth below, it says.

In the descent, which was watched closely by two-score of men, the cat spread herself out like a flying squirrel fell slowly, and alighted as cats always do, on all fours.

After turning over on the soil a few times, as if dazed, she prepared to leave the grounds. She had got almost beyond the shadow of the monument, when a dog belonging to one of the workmen pounced upon her and killed her, she of course not being able to run as fast as usual after performing such an extraordinary feat.

One of the men rescued the body of the cat, smoothed out her silky coat and turned the remains over to a representative of the Smithsonian Institution, who mounted the skin and placed it under a glass case.

AN IMPROVED BOOKCASE.

BOOKS, weekly and monthly reviews, pamphlets, etc., have become exceedingly numerous in our day. Everyone writes, and everyone "rushes into print." It is true that, among these numerous products of the press, there is a host of things to be thrown into the waste basket; but, after a selection has been made at the end of the year and only such things have been preserved as are useful for reference from time to time, space is still wanting in the bookcase. It is necessary to discard old books and replace them by new ones, and the various sizes necessitate a rearrangement that makes the shifting of the shelves obligatory. It is then that we perceive how defective and inadequate

FIG. 1.—AN IMPROVED BOOKCASE.
C D, wooden frame; A B, iron rods; P, sliding support; H, corner clamps.

are the wooden supports upon which the latter are usually mounted. It is in order to remedy such inconveniences that M. Galante has devised a very practical method of support that permits of the shifting of the shelves with the greatest facility.

The two sides of the bookcase are provided with iron rods, *A* and *B* (Fig. 1), that pass through recesses formed in the extremities of the wooden shelves. Upon these rods rest the supports, *P*, the details of which are shown in Fig. 2. They consist of a crosspiece provided with two guides, *H*, that bear against the rods upon which they are made to slide; but the ends of a curved strip of steel press against the rods, *A* and *B*, and prevent any sliding in a downward direction. The more heavily the support is loaded the more firmly it remains in place. In order to move it upward it is only necessary to push it. In order to move it downward the fingers are passed through the rings, *C D*, fixed to the ends of the spring, and the latter are made to approach each other. The extremities then leaving the contact at *A* and *B*, it is possible to lower the support. After the latter has reached the point desired the rings are simply freed in order that it may be fixed anew.

This arrangement is applicable to any bookcase; but in order to respond to the ever-increasing need of more

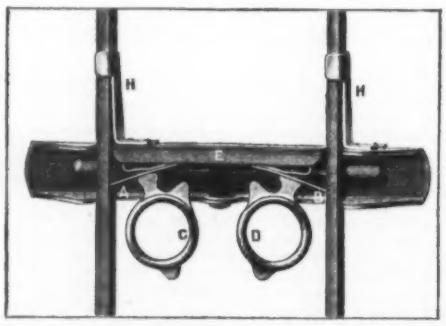


FIG. 2.—DETAILS OF THE SLIDING SUPPORT.
H, slides; E, part supporting the shelf; A B, spring; C D, rings acting upon the spring.

room mentioned above it is well to have cases that may be placed almost anywhere. With this object in view, M. Galante has devised the wall case shown in Fig. 1. The frames, *C D*, that carry the rods, *A* and *B*, are of oak, and are fixed at the desired height upon brackets, and held against the wall by clamps. The side uprights, *C*, are provided with a strip of wood in which recesses may be formed in order to make it fit the moldings of the woodwork. As for the front, *D*, that is provided with moldings to suit the taste and the top is crowned with a cornice in keeping with the rest of the decoration. The entire affair is well combined and easily mounted and dismounted and made to match the rest of the furniture, so that it may be placed even in the most elegant apartments.—For the above details and the engravings we are indebted to La Nature.

MANUFACTURERS' IMPORTATIONS.

THE manufacturers of the country are now importing more than a million dollars' worth of material for their workshops every day in the year, and are exporting more than a million dollars' worth of their finished product each day. The imports of the manufacturers' materials in the eight months ending with February, 1902, were, according to a statement just issued by the Treasury Bureau of Statistics, $270,202,774, and the exports of finished manufactures during the same period were $257,907,430. Thus in 243 days of the fiscal year the manufacturers have imported $270,000,000 worth of material and exported $257,000,000 worth of their finished product, thus averaging more than $1,000,000 of both imports and exports for every day of the fiscal year up to the beginning of the present month. The importation of manufacturers' materials has been greater in the eight months just ended than in the corresponding period of any preceding year.

The following table shows the total imports of manufacturers' materials and exports of manufactures in the eight months ending with February in each year during the last few years. It will be seen that within less than a decade the importation of manufacturers' materials has more than doubled, and that the exportation of manufactures has also more than doubled:

Eight months ending with February.	Imports of manufacturers' materials.	Exports of manufactures.
1894	$130,171,766	$123,288,257
1895	169,868,576	116,828,996
1896	221,875,758	144,062,141
1897	159,533,502	174,180,920
1898	178,611,860	180,606,072
1899	170,959,002	206,822,334
1900	253,231,318	268,537,972
1901	213,077,923	269,866,656
1902	270,202,774	257,907,430

On the export side of the account manufacturers are showing an improved record. The Bureau of Statistics reports of exports of manufactures during both January and February show a decided increase over the corresponding months of 1901, the gain in the two months in question being more than $3,000,000 over the same months of the preceding year. The exports of manufactures in the 28 days of February were $31,740,842, against $30,302,592 in February, 1901. In practically all articles except iron and steel there has been a complete recovery from the temporary check in exports of manufactures noted a few months ago. Copper exports, for instance, in February of this year were $4,210,361, against $3,155,774 in February, 1901; though for the eight months the total still stands $8,500,000 below that of the same period of the preceding fiscal year. Exports of refined mineral oils for the eight months ending with February, 1902, are $44,689,987, against $41,880,021 in the corresponding months of the preceding year. Even iron and steel exports show a marked improvement, the total for the month of February being $7,358,296, against $7,959,218 in February, 1901, and $8,549,157 in February, 1900. For the eight months ending with February the exports of iron and steel manufactures are $64,668,424, against $81,575,685 in the corresponding months of the preceding year. Manufactures of cotton show an increase of $9,000,000 over the corresponding period of last year; manufactures of leather, an increase of $2,000,000; paraffin, which a few months ago showed a decrease, now shows a gain of nearly $2,000,000 over the corresponding months of last year, while in nearly all of the other important manufactured articles exported there are gains over last year. The total exports of manufactures fall for the eight months ending with February but $12,000,000 below those of the same months of last year, while the fact that manufactures of iron and steel alone are $17,000,000 less than in the eight months of last year shows that in other articles there has been a decided gain.

WORD-BLINDNESS.

THE faculty of speech is a complex function, and comprises not only the mechanism of articulation, but also a revival of various sense-memories, representing the great number of impressions received from without. Paralysis of the motor apparatus of articulation, while it prevents speech mechanically, does not necessarily interfere with those processes that underlie the psychic activity whose expression we know as intelligent speech. On the other hand, we may have, without interference with the mere act of articulation, such derangement of receptive or emissive cerebral function as to impair or even to abolish the power of speech. To the latter condition the designation aphasia is applied, and three principal varieties have been distinguished, namely, motor, sensory and amnesic. It is difficult, however, to maintain any such classification, and not rarely the speech-disturbance is complex, although one form may predominate, and all sorts of combinations may take place. Thus, the power of speaking spontaneously (with or without confusion) or by repetition, or of reading, to one's self or aloud (with or without comprehension) or of writing, spontaneously (with or without confusion), or on dictation or by transcription, or of comprehending the spoken, written or printed word or figure or other symbol, may be lost, one or more, in varying degree.

A condition closely related to aphasia is that known as mind-blindness, or object-blindness, or as visual or optic aphasia, in which, although the object is seen, the patient is unable to recognize or to designate it. Of this a special variety is known as word-blindness; there may also be a letter-blindness. Four

striking examples of word-blindness have been recently reported by Dr. James Hinshelwood (Lancet, February 8, 1902, page 358), who has already made several contributions to this interesting subject. In one of the present cases a man familiar with four languages was found almost totally word-blind to one, less word-blind to two, and not at all word-blind to the fourth. The explanation of this strange phenomenon is thought to reside in the fact that only a portion of the center in the cerebral cortex—probably situated in the supramarginal and angular gyri of the left hemisphere in right-handed persons—in which are lodged the word-visual images of language is destroyed, the cells subserving the function for each language forming separate groups. It has already been observed that a patient familiar with two languages may be word-deaf to one and not to the other, and an analogous explanation is probably applicable also here. In the second and third cases of word-blindness the patient could read printed letters quite well, but written letters with difficulty if at all. There was little interference with the reading of figures in these two cases, as well as in the fourth, in which there was complete word-blindness and also letter-blindness and an inability to designate by name objects seen, although these were apparently recognized. The first patient retained the power of reading musical notes.

In the second and fourth cases there was right lateral homonymous hemianopsia. The frequency with which this association has been noted suggests that the centers for visual memory and for the right halves of both visual fields, or the paths to them, must lie close together, and this inference is confirmed by pathological evidence. The question as to recovery from word-blindness depends upon the nature and the situation of the causative lesion. If this be destructive, recovery is quite out of the question, except in so far as the opposite hemisphere can be educated to take up the lost function. Whenever syphilitic infection is even suspected a vigorous course of mercury and iodid should be instituted.—Medical Record.

NEW TREATMENT OF NIOBITE—PREPARATION AND PROPERTIES OF CAST NIOBIUM.

From the French of M. HENRI MOISSAN. Memoir presented to the Académié des Sciences.

THE study of the metal niobium is still very incompiete, and we are unacquainted with its characteristics. Henry Rose endeavored to prepare this simple body by decomposing potassium fluoxyniobate by sodium. According to Delafontaine, the black powder obtained in this reaction is only a lower oxide of niobium. In the course of his valuable experiments on the fluorine compounds of niobium and of tantalum, Marignac studied this question. He first reduced potassium fluoniobate by sodium and collected a powder of blackish or grayish color, having a density varying from 6 to 6.6, which he regards as a hydride of the formula NbH. He then reduced potassium fluoniobate by aluminium and obtained an alloy of niobium and aluminium approximating the formula $NbAl_3$. Lastly, M. Roscoe, by the reduction of niobium chloride in a current of hydrogen, obtained a powder of a grayish color, having a density of 7.06, and not containing more than 27 per cent of hydrogen.

Treatment of Niobite.—My experiments were commenced with a niobite of American origin, having a density of 5.75. It was in the form of massive clustered and interlaced crystals and contained niobic and tantalic acids, 83.20 per cent; iron, 7.58; manganese, 3.82; also a small percentage of silicon. This niobite, crushed coarsely, was picked out by hand, so as to eliminate the pieces rich in silica.

The mineral, reduced to powder, received an addition of burnt sugar, was then massed together by pressure and heated in the electric furnace from 7 to 8 minutes with a current of 1,000 amperes under 50 volts. During the experiment, the whole of the manganese and the greater part of the iron and silicon were volatilized. There remained a melted mass of clear gray color having crystalline fracture, and containing all the niobium and tantalum, combined with carbon, without free graphite. This fused mass contains 2.18 to 2.34 per cent of carbon. Each preparation may yield 600 grammes.

The alloy was reduced to a coarse powder and subjected to the action of a solution of pure fluorhydric acid, increased with a small quantity of nitric acid. After filtration, the liquid was treated with the fluorhydrate of potassium fluoride, in such a manner as to produce, along with the tantalic acid, a fluotantalate, and, with the niobic acid, a fluoxyniobate. These two salts were separated, on account of their difference in solubility, by following exactly the delicate method described by Marignac. The small amount of iron in the fluoxyniobate was precipitated by ammoniacal sulphydrate. The potassium fluoxyniobate was purified by successive crystallizations. When the heating of the niobite and carbon has been well managed in the electric furnace, the fused mass ought to yield, by solution in fluorhydric acid, a colorless liquid. If any manganese remains, a brown solution is formed, which is due to the action of the fluorhydric acid on the manganese carbide.

The potassium fluoxyniobate was converted into niobic acid which, after calcination, is perfectly white.

Preparation of the Niobium.—A mixture of niobic acid, 82 per cent, burnt sugar, 18 per cent, corresponding to the formula $Nb_2O_5+5\,C=2\,Nb+5\,C\,O$, was slightly moistened with turpentine pressed into the form of small cylinders, and slowly calcined in the Perrot furnace. A certain number of these cylinders were then arranged in a charcoal boat, placed in a tube of the same substance in my electric furnace. The time of heating is very short. With a current of 600 amperes and 50 volts, it ought to be about three minutes. The decomposition is violent. The niobic acid is fused rapidly, and the reaction takes place with an intense effervescence. As soon as this ceases, the heating is stopped. After cooling, the boat contains a well smelted ingot, slightly adherent to the graphite and having a distinct metallic cleavage.

Physical Properties.—The cast niobium is quite hard; scratches glass deeply and quartz easily. It has been impossible to liquefy it with the oxyhydrogen blowpipe. Its fusing point is therefore above 1,800 deg. In the electric furnace it is easily liquefied.

Chemical Properties.—Cast niobium, heated slowly in an atmosphere of fluorine, becomes incandescent and yields copious white fumes of a volatile fluoride. At the temperature of + 205 deg. it is attacked by chlorine, with intense discharge of heat, and the volatile niobium chloride, $NbCl_5$, of a golden yellow color, is produced. Bromine vapor attacks it at a slightly higher temperature, producing a yellowish sublimate. At the fusing temperature of glass iodine has no action.

The cast niobium, reduced to powder, and heated in a current of oxygen, takes fire at 400 deg.; the incandescence is very vivid, and a light niobic acid is formed, which is abundant at the moment of combustion. The action is identical when heated in the air, although the temperature of the combination may be more elevated. Sulphur vapor, at the temperature of 600 deg., attacks it superficially only. Selenium and tellurium have no action upon it at the same temperature.

When this powdered niobium is heated in a current of nitrogen at 1,200 deg., each particle of the metal is covered with a beautiful yellow coating of a nitride of niobium, whose composition will be given later. But, at a temperature of 500 deg. to 600 deg. nitrogen, phosphorus, arsenic and antimony are without apparent action.

The influence of carbon is quite curious. Kept for a short period in the liquid state, in presence of graphite, niobium slowly absorbs carbon, which enters into combination. On heating the niobic acid in presence of an excess of carbon, I have not yet obtained metal containing graphite in excess.

Niobium combines with the metals with difficulty. Sodium, potassium and magnesium may be distilled with it without any combination. There is no combination with zinc. Heated with soft iron at the fusing point of the metal, a small quantity enters into combination. The examination of a polished surface of this alloy of iron and niobium has shown: (1) some pieces of unchanged niobium; (2) some irgular striæ of a combination of iron and niobium, or a double carbide of iron and niobium; a very abundant ferruginous medium serving as solvent.

Gaseous chlorhydric acid attacks the metal below dull red heat, and without incandescence, hydrogen is set free, and a yellowish white chloride is sublimated.

At ordinary temperature, niobium reacts on water; even at 600 deg., steam and hydrogen sulphide have no action on the powdered ingot.

Ammoniacal gas, passing at red heat over this fine powdered metal, is completely decomposed into hydrogen and nitrogen. Niobium, in this experiment, does not change in weight, and a decomposition would seem to occur, similar to that described by Messrs. Ramsay and Young.

Sulphurous acid gas is reduced with incandescence at about 600 deg. Nitrogen protoxide, at the dull red, produces a very intense combustion, and a gray powder remains, containing no nitrogen. The reaction is incomplete. With nitrogen dioxide the same result occurs, with a more vivid combustion. Phosphoric anhydride is reduced by niobium at the dull red, with a copious discharge of phosphorus vapors. Carbonic acid gas is decomposed at red heat with production of carbon oxide. Iodic acid and arsenic anhydride are reduced with incandescence at a lower temperature. Chromium sesquioxide, placed in the electric furnace, with ingot of niobium, is easily reduced and yields a brittle alloy of chromium and niobium.

Lead protoxide and bioxide, on the addition of pulverized niobium, deflagrate when slowly heated. The two chlorides of mercury are decomposed at the dull red, with formation of niobium chloride, and mercury is set free.

Cast niobium is attacked by potash infusion; an alkaline niobate is formed and hydrogen is disengaged.

Potassium sulphate is reduced in fusion by niobium, with production of potassium sulphide, and some small blue crystals insoluble in boiling water, appearing under the microscope as small cubes. Potassium chlorate does not react on niobium before its temperature of decomposition is reached, but at this temperature reaction takes place with vivid incandescence. Likewise, potassium nitrate, heated at its temperature of decomposition, yields, on contact, a violent disengagement of nitrous vapors. A solution of fluorhydric acid slightly attacks this metal. On the contrary, chlorhydric and nitric acids have no action, even at their boiling points. Sulphuric acid is not decomposed, cold, by niobium, when reduced to a fine powder. On heating it is attacked very slowly; the acid becomes brown and some niobic acid is precipitated. Niobium is not attacked by *aqua regia*, but is dissolved rapidly in a mixture of fluorhydric and nitric acids.

Analysis.—Determination of the carbon in the fused niobium has been made by combustion in oxygen. The metal, powdered fine, was placed in a boat and heated in a Bohemian glass tube. The combustion occurred with great facility and was quickly completed. From the weight of carbonic acid collected the weight of the combined carbon may easily be calculated. In all the ingots prepared so far, free graphite has not been met with. Following is the result of analysis of some of the samples: Combined carbon, 3.40, 3.15, 2.95, 2.71, 2.30.

Conclusions.—The employment of the electric furnace allows of obtaining with great facility a fused mass of niobium and tantalum, from which these metals may be separated in the form of oxygenated compounds.

Niobic acid, which was irreducible by carbon at the highest temperature of our ordinary furnaces, and at that of the oxyhydrogen blowpipe, may be reduced in my electric furnace and yield a very hard ingot, containing only a small quantity of combined carbon. This mass, solid at the fusing point of platinum, almost impervious to attack by the acids, having no action at red heat on steam, burning readily in oxygen while producing a stable acid, possesses at the same time some very curious reducing properties. This series of reactions separates niobium from the metals, and places this simple element near boron and silicon.

THE ELECTRICAL AND MAGNETIC PROPERTIES OF IRON ALLOYS.

FOR the past ten years Prof. W. F. Barrett, F. R. S., of Dublin, in conjunction with Mr. W. Brown, B.Sc., and Mr. R. A. Hadfield, the managing director of the Hecla Steel Works, Sheffield, has been engaged in researches on the electrical and magnetic properties of iron alloys. As each series of alloys was made, the samples were cast into ingots. After rejecting unsuitable pieces, there remained 110 specimens, which were forged into bars, raised to bright-red heat, and rolled out to rods 40 inches long, 0.2 inch in diameter. These rods were tested, and afterward returned to Sheffield for thorough annealing at 1000 deg. Cent. and slow cooling during 100 hours, preparatory to further testing. Of the rods tested, 59 represented binary alloys, 44 ternary alloys, and 7 contained more than three elements, besides iron.

As standards of comparison there were employed hard-drawn electrolytic copper rods, and Swedish iron rods containing 99.89 per cent of iron, and thus only one-tenth per cent of total impurities. Rods and wires of this iron gave practically the same electric conductivity—namely, 16.5 and 16.44 (copper = 100). The resistances were determined by measuring the fall of potential over known lengths of rod; this method indirectly allows conclusions to be drawn as to the homogeneity of the materials. The highest resistance of any commercially useful wire—namely, 97.5 microhms per cubic centimeter—was found in an alloy of iron with 25 per cent of nickel and 5 per cent of manganese. This alloy is also distinguished by its thermo-electric properties and a low temperature coefficient; it is not expensive, and can easily be drawn into wire. An alloy with 15 per cent of nickel and 5 per cent of manganese makes a good material for resistance coils. It is known as resista, or rheostene. Prof. Barrett has used it for over five years, and finds that it has not deteriorated; some users have, however, complained that thin wires of this alloy turn brittle.

Looking at the general result of adding any metal to iron, we see that all admixtures diminish the conductivity, though the additional element—e. g., copper—be itself a better conductor than iron, and that the specific resistance of the element added affords no clew as to the intensity of its effect. Thus aluminium-iron alloys are far worse conductors than nickel-iron alloys of the same percentage, although aluminium conducts three times as well as nickel. Tungsten reduces the conductivity of iron least of all elements tested, and carbon undoubtedly most. The effect of carbon is, in fact, so marked that we can, in the absence of other impurities, guess the carbon percentage from the resistance. In all cases the conductivity curves fall very rapidly at first, and much more slowly afterward. In other words, the effect of a small quantity of any additional element is much stronger than that of subsequent additions to rich alloys. This is, of course, a fairly general rule. But Prof. Barrett arrives at the very interesting conclusion that the specific resistances (column S. R. of the table below) and the specific heats (column S. H.) of the 1 per cent alloys increase as the atomic weights (A. W.) decrease. The following table exemplifies this observation, which is a suggestive novelty so far as the specific heat is concerned:

Iron alloyed with	S. R.	S. H.	A.W.
Tungsten	0.9	0.035	184
Cobalt	2	0.107	59
Nickel	2.5	0.109	59
Chromium	3.0	0.1(?)	52
Carbon	5	0.113, 0.16	(?)
Manganese	5.2	0.122	55
Silicon	10.3	0.183	28
Aluminium	11.1	0.212	27

Several qualifications have, however, to be made as regards this table. It will be noticed that chromium does not quite fit into the row. Two values are given for the specific heat of carbon, 0.16 (graphite), 0.113 (diamond); what atomic weight we are to assign, we do not know. But the chief point is that none of the materials were pure. Traces of carbon, manganese, and silicon cannot be eliminated. That signifies, in the first instance, that we are uncertain as to the properties of the pure metals—the chemist smiles at the mention of "pure" iron—and in the second instance, that we cannot speak definitively of their comparative effects. Further, none of the iron rods examined contained more than 1¼ per cent of carbon, so that the range of tests of carbon alloys was very limited; and, lastly, the peculiar condition or modification in which the carbon exists in the iron is undoubtedly of influence. For these reasons Prof. Barrett did not embody carbon in the table in which he summarized certain of his results, though he gave the respective figures which we have added to the table; nor did he place cobalt with the other metals. Prof. Barrett states that the cobalt and nickel curves lie close to one another. Further research will probably bring out differences between nickel and cobalt. The chemist has long recognized that the unmistakable resemblance of these two metals is superficial, and consists chiefly in their having both somewhat analogous peculiarities, which may frequently be called irregularities. G. Reichardt is at present investigating cobalt-copper alloys in the Reichsanstalt; and he finds them of little use so far, except for thermo-couples; and magnetically cobalt-copper alloys and nickel-copper alloys differ most decidedly from one another.

Annealing—to return to Prof. Barrett's results—always diminishes the resistance of the alloys, often to a remarkable degree. High-grade manganese steel is hardened by rapid cooling, and softened by slow cooling. Hardness, as a rule, goes with resistance. For his magnetic researches the author found a magnetometer method, making use of the magnetic system of a Lord Kelvin graded galvanometer, on the whole most convenient, considering the length of the specimens and the range of the experiments; Ewing's permeability bridge and the ballistic method were also applied. The length of the rods being about 200 diameters, a correction had to be made for the demagnetizing reaction of the ends. Some rods were turned down to diameters of less than 0.2 inch. The best Lowmoor iron

was not quite so permeable as the Swedish iron. Small quantities of manganese seriously diminish the permeability of iron, as they diminish the conductivity; alloys with 13 per cent are practically non-magnetic. But the presence of carbon and its condition have to be considered; when 3 per cent of manganese is present, a high carbon percentage is magnetically detrimental, while high manganese alloys are magnetically improved by an addition of carbon; a poor magnetic manganese steel is also very hard. The effect of copper is not great. Chromium makes iron hard and magnetically poor—i. e., decreases the permeability and increases the coercitive force. Tungsten imparts very high remanence and coercitive force, and permanent magnets should be made of steel containing from 5 to 7 per cent tungsten. These remarks apply to well-annealed specimens, and would hold still more for unannealed materials. Composite alloys containing more than two metals may behave very curiously. A steel of composition Fe 86.74 per cent, Mn 13.0, CO 26 per cent, is practically non-magnetic, and, unfortunately, also very hard and not machinable at all. But a steel with 79.35 Fe, 10.25 Mn, 9.0 Ni, and 1.4 C, is also non-magnetic, but it can easily be machined. Thus we see that while nickel steels are fairly magnetic, they render manganese steels, themselves also magnetic, practically non-magnetic.

The most remarkable observations were, however, made on some alloys containing only one of the two elements, silicon or aluminium. A steel containing 2½ per cent of Si exhibits higher permeability and lower hysteresis with high induction than the purest Swedish charcoal iron, and a 2½ per cent aluminium steel proved to be magnetically still superior. Prof. Barrett had many very instructive curves to explain these and other features, when recently he read before the Institution of Electrical Engineers a paper "On the Electrical Conductivity and Magnetic Properties of Upward of One Hundred Different Iron Alloys." But his two simple experiments were sufficiently convincing and startling. Any iron rod will show magnetic polarity, as we well know. But the steel with 2½ per cent of aluminium had its accidental polarity reversed every time it was turned in the very feeble magnetic field of the earth; that is to say, when held vertical, the lower end would repel a long magnetic needle, and thus demonstrate itself to be a north pole. But when the rod was turned, the now lower end would again be a north pole. Prof. Barrett further placed thin rods within a long solenoid, and listened to the Page effect—the sound given out by the magnetized wire. The audience could just hear the sound of the Swedish iron; the aluminium wire hummed loudly enough to astonish everybody.

[Concluded from SUPPLEMENT No. 1374, page 22024.]

ELECTRIC FURNACES.*

By BERTRAM BLOUNT.

CALCIUM Carbide Furnaces.—The Willson furnace differs but little from the vertical form of Siemens, but is worthy of notice because it was employed in the early days of carbide manufacture, although originally intended for the reduction of aluminium, a purpose for which it was eminently unsuited. As will be seen from the figure (Fig. 9), its construction is of the simplest. There is a casing of fire-brick, *A*, a carbon vessel, *B*, with a tapping-hole, *D*, and a cover, *E*, through which passes a carbon electrode, *C*, adjustable in height. The charge is introduced little by little, and, as it is heated, fuses, forming a pool of calcium carbide acting as the electrode between which and the carbon rod an arc is maintained. The tapping-hole allows the fused product to be run off, and thus should permit the furnace to be worked continuously. For the successful attainment of this end, however, a considerable modification is needed, the hearth being much shallower and the tapping very frequent. The high fusing point of calcium carbide makes all continuous processes depending on its being run out from the zone of formation somewhat difficult to work. Thus it comes about that most carbide is "block" carbide. Another furnace of a simple kind which has been found fairly effective in practice is shown in the accompanying figure (Fig. 10). *A* is a cast iron box lined with thick carbon blocks, *B*. The cavity, *C*, constituting the furnace proper is rather shallow; it is provided with a tapping-hole, *E*. The upper electrode, *D*, is a massive carbon rod of square section. The lower end is just clear of the top of the box and of the fused part of the charge, the liquid carbide filling the box. The raw materials (crushed coke and lime) are fed by hand into and around the arc which plays between the upper electrode and the carbide in process of formation. By judicious feeding the arc can be smothered to some extent, but even at the best a great part of it is exposed, and a considerable loss of heat results. The upper electrode can be gradually lowered as it is consumed. The chief merits of the furnace are its cheapness and simplicity, and the fact that it can be worked continuously, the carbide being allowed at intervals to flow out at the tapping-hole, and fresh raw materials supplied round the upper electrode. A certain amount of hand labor is required, but it is not of a severe character. It will be seen that this furnace is not unlike the Willson furnace, but that no attempt is made to inclose the arc by the furnace walls. This is probably because in the Willson furnace, the walls being conductive, themselves form one of the electrodes and get unduly hot. A non-conductive refractory material such as magnesia might turn the balance of advantage in favor of the Willson form.

Another type of furnace is that designed to make "block" carbide. The King furnace is an example (Figs. 11 and 12). It consists of a brick chamber, through the top of which the end of the upper electrode, *C*, passes; it is fitted at the bottom with a truck, *A*, which can be run into position and removed at will, and serves as a box to contain the carbide formed. The truck can be given a small reciprocating motion to help to shake down the charge, and to prevent the path of the current from being too localized. The raw materials are fed in little by little through

* Paper read at the Manchester section of the Institution of Electrical Engineers, March 4.

side passages in the brickwork, and are exposed to the heat between the electrodes. The upper electrode is slowly raised, and thus a block of carbide is gradually built up. A second form of block carbide furnace is that used by the United Alkali Company at Widnes. The distinctive merits of this furnace are that the upper electrode is continuously immersed in the raw materials, and that the vessel containing these is slowly rotated so as to bring every part of the charge into the zone of activity. Thus there is maintained a constant supply of raw material immediately beneath the

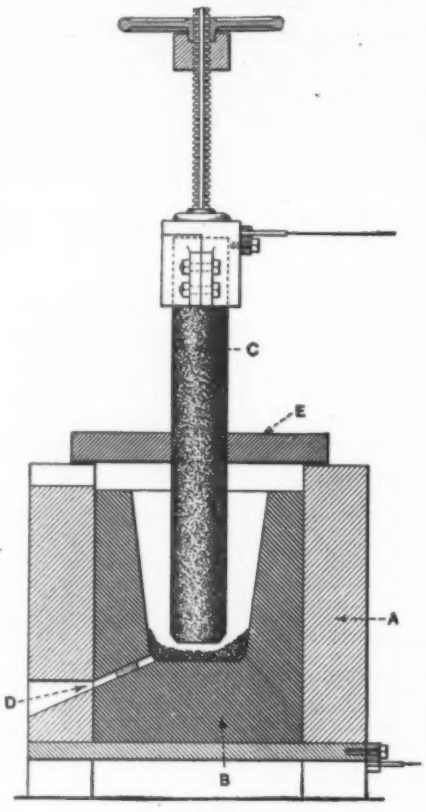


FIG. 9.

upper electrode, and no arc can form. The furnace is of the resistance or Cowles type, and the waste involved by the use of an open arc is avoided. In this way a block of carbide is gradually built up by feeding in fresh raw material (which may be done mechanically) and raising the upper electrode. When the block is finished the operation is stopped, the front of the crucible opened, and the block removed. Adherent raw material from the sides and crude carbide containing admixed raw material from the top are knocked off, and the sound well-fused block carbide broken up for packing. It will be observed that no attempt is here made to tap the carbide, and indeed it is doubtful whether this type of furnace could be used in this way without radical modification. In general, it may be said block carbide is inferior to tapped carbide, but that its manufacture is easier. There is more chance of the carbide made in blocks inclosing unconverted raw materials. It does not follow from this that the manufacture of block carbide is to be condemned. The inferiority of the product may be compensated for by a better utilization of energy, and if the carbide is bought on its assay value, the consumer may be perfectly willing to buy the lower grade product at a proportionately lower price. There are many forms of carbide furnace which, if examined with knowledge, might be grouped under one or other of the heads given above. It may be useful to consider on what lines a carbide furnace should best be constructed, and to attempt the design of such a furnace. In the first place, the furnace should make car-

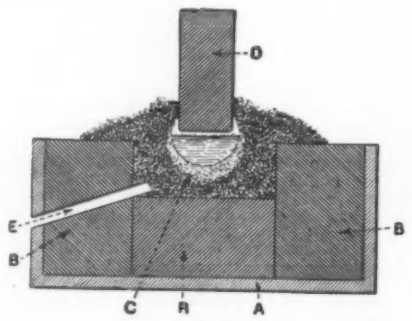


FIG. 10.

bide sufficiently fluid to be tapped and run away from the sphere of action. This requirement rules out block carbide, and makes the furnace of the continuous type. Next, it should have an exposed arc, and the heat electrically generated should be conserved as much as possible. Thirdly, it should be so constructed that the containing vessel is hardly effected by the high temperature necessary to form carbide. I have endeavored to embody these ideas in the furnace illustrated here (Fig. 13). The furnace consists of a fire-brick casing, *A*, with a magnesia lining, *B*. The shape is conical, and at the bottom the furnace is contracted to form a hearth for the fused carbide. The tapping-hole is at the bottom of this contracted part. The lower electrode is a carbon plate, *C*, and the upper electrode a massive carbon rod, *D*, of circular section. The raw material is fed into the annular space between the upper electrode and the magnesia lining in sufficient quantity to inclose and smother the zone of highest temperature. This feeding may be done mechanically, and various devices suggest themselves, but it is probable that hand feeding will be at least as effective, because the amount of labor required is not great, and the variation of conditions is so large that the greater elasticity of hand feeding may be a positive advantage. For the safety of the workmen it may prove necessary to draw off the carbon monoxide by a fan through a side flue, leaving the top of the furnace open and uninterrupted for manipulating the charge. In operating the furnace a pool of carbide will be formed and maintained of such depth as to cover the hearth and to allow of tapping the pure and fairly fluid product, but the depth of this pool will be kept small, and special attention will be directed to maintaining its fluidity by the means indicated below. It will be observed that the cross section of that part of the furnace immediately surrounding the lower end of the upper electrode is considerably greater than the cross section of the hearth on which the carbide collects. Thus the smaller section of the

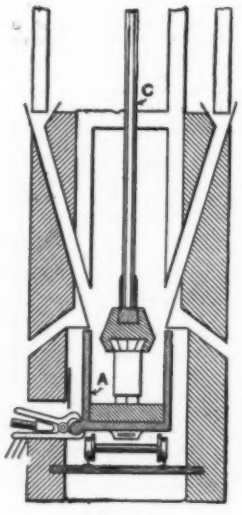


FIG. 11.

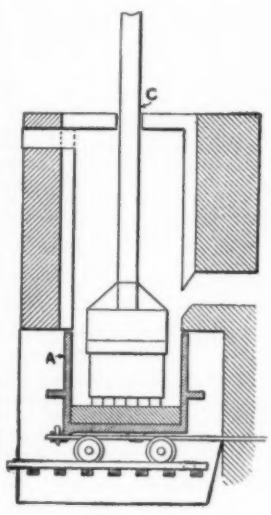


FIG. 12.

column of carbide compensates for its conductivity being greater than that of the raw materials; the desired temperature can be maintained, and the carbide will remain sufficiently fluid to be tapped.* It is evident that a furnace of this description, which is continuous and has a large part of its contents at so high a temperature as to be fluid, can hardly be worked on any system which depends on the raw materials forming a protective lining, for this, from the nature of the case, cannot protect the hearth or crucible where a pool of fused carbide is always present. That part, at least, must, therefore, be protected by a refractory lining. Carbon might be used but for its conductivity, which would allow the current to reach the upper electrode without passing through the fused carbide, leaving this comparatively cool and liable to solidify. Magnesia is the most suitable material. It is not reduced by carbon, does not yield a carbide and is extremely infusible. It is not a good non-conductor of heat, but the difficulty thus caused can be overcome by supplying the lining with a backing of fire-brick, as shown in the figure. I am of opinion that this will be the type generally adopted as long

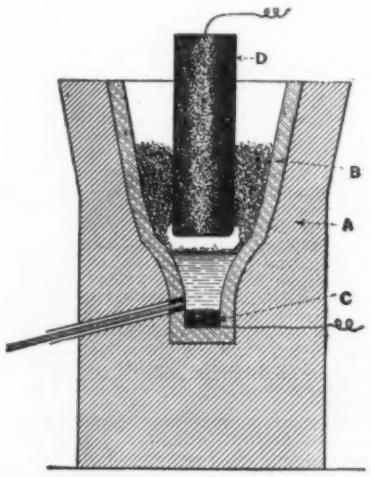


FIG. 13.

as the carbide industry is at its present somewhat crude stage. If it is found feasible to heat the raw materials by non-electrical means to a point approaching the temperature of formation of carbide, then to raise them through the last 1,000 deg. C. or so electrically, to work regeneratively, and to utilize the by-product carbon monoxide, the aspect of affairs will be

* It is curious that no one appears to know the fusing period of calcium carbide. Moissan speaks of its being liquid at a red heat, but those who have seen it tapped from a carbide furnace will probably agree that this is an understatement. I have failed to fuse it in an injector furnace capable of giving a temperature of 1,200 deg. C.

profoundly changed. Until then the simple type of furnace described may be considered as an attempt to meet present needs in a rational manner.

It is of considerable interest to manufacturers, more particularly those who have at their disposal large quantities of waste power from blast furnace gases, or the gases from recovery coke ovens, that a few weeks ago a decision was given in the law courts by which the manufacture of calcium carbide in the electric furnace has been declared public property in this country. Of course, it is possible that an appeal may be entered against this decision, but I for one do not regard it as likely to succeed. As the matter stands at present, it has been held by Mr. Justice Buckley, in an exhaustive judgment, that the Willson patent for the manufacture of calcium carbide is invalid for want of novelty. Those who have studied the question are aware that Moissan's discovery of the method of preparing calcium carbide in an electric furnace was published some time prior to the date of the patent, and this publication was so full and explicit that everything necessary for the industrial preparation of calcium carbide in the electric furnace was thereby disclosed. No doubt there will still be rights in particular forms of apparatus, but the broad fact that calcium carbide can be manufactured by heating lime and carbon together in an electric furnace has been publicly set forth and is open to every one to utilize.

The Acheson Carborundum Furnace.—This furnace is of the resistance type, but differs from the Cowles

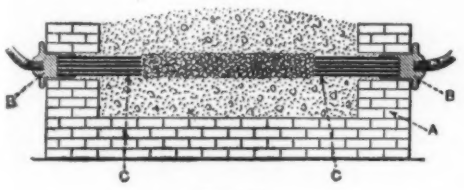


FIG. 14.

by having a conductive core distinct from the charge to be heated. The general arrangement is shown in the figure (Fig. 14). The furnace is about 15 feet by 7 feet by 7 feet, and is a rough brickwork structure, *A*, which can be taken down and easily reconstructed for each run. It is merely designed to keep the mass of raw material together, and to provide support for the electrodes. Each electrode is formed of a bundle of carbon rods, *C*, set in a heavy metal holder, *B*, by means of which the leads are attached. They project into the furnace, and between their ends is built up a core of broken coke, round which is packed the charge, consisting of 34.2 per cent of coke, 54.2 per cent of sand, 9.9 per cent of sawdust, and 1.7 per cent of common salt. This charge weighs about 10 tons, and if completely converted into silicon carbide (carborundum) should yield about 4 tons of this substance. The average quantity obtained per run is about 2 tons, therefore the yield is poor. A furnace such as that described will absorb about 1,000 horse power, and take some 36 hours for a complete trip. It will be seen that the apparatus is rudimentary in its simplicity, yet it is hard to say in what manner it could be improved. The product, silicon carbide, must be prepared crystalline, and so it does not actually fuse, but rather is formed by the action of carbon on silica in the state of vapor; its preparation by any process

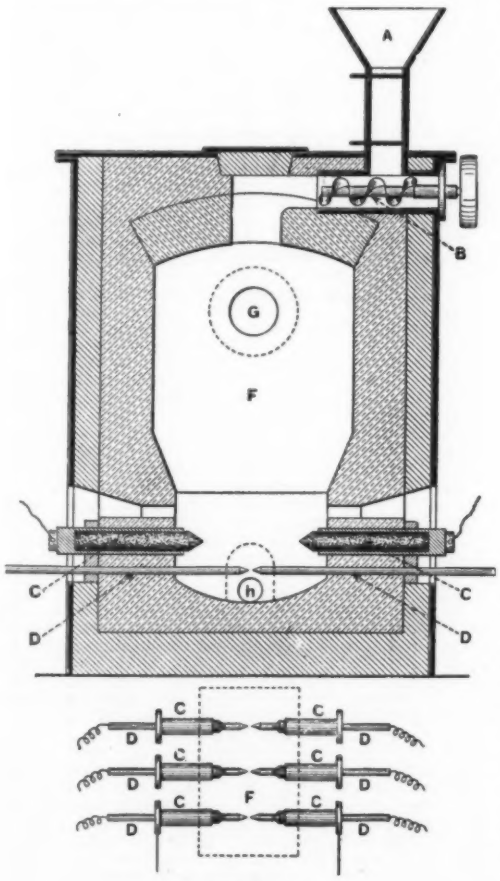


FIG. 15.

involving settling out or tapping, as in making block carbide or tapped carbide respectively, appears out of the question. Seeing that only one particular zone of temperature, viz., that immediately surrounding the coke core, is sufficiently high to insure complete conversion of the raw materials into silicon carbide, it follows that the heat in the outer layers must be chiefly wasted. At present the industry of making carborundum, though interesting and potentially important, is not so large as to have attracted much attention from inventors.

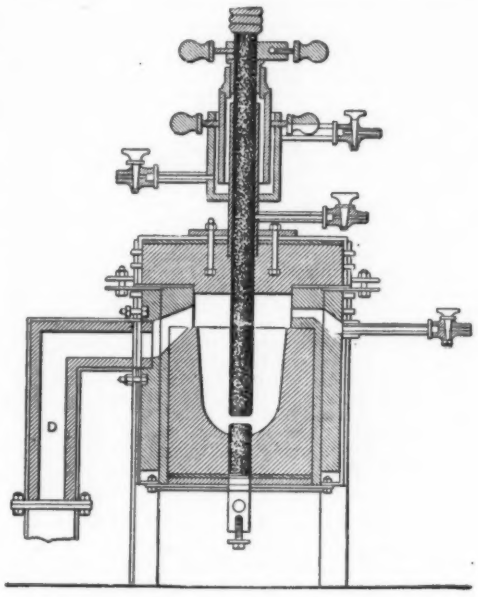


FIG. 16.

The Manufacture of Phosphorus in the Electric Furnace.—One of the most successful applications of the principle of the electric furnace is to the manufacture of phosphorus. For many years phosphorus was made by heating a mixture of phosphoric acid and carbon in small retorts set in an ordinary furnace, and, of course, heated externally. The heavy consumption of fuel and frequent breakage of retorts usual in such operations made the method expensive. It occurred independently to Dr. Readman and to Mr. Thomas Parker, in conjunction with Mr. Robinson, that the heating could be better accomplished electrically, and in 1888 patents were taken out by both inventors. Realizing that their interests lay together, the patentees joined forces, and a process resulted so far in advance of the older method of heating as to replace it completely. The Parker furnace, as originally patented, is shown in Fig. 15. It consists of a fire-brick chamber, *F*, with a feeding hopper, *A*, at the top, so arranged that the charge can be introduced without allowing access of air, and a side flue, *G*, to carry off gases and vapors produced during the operation of the furnace. The lower part of the furnace is contracted to form a hearth, and the charge at this part is strongly heated by the passage of a current between two sets of electrodes, *C C*, placed opposite each other. The flow of the current is started by small pilot electrodes, *D D*, and when the charge has been heated by these the whole mass is maintained incandescent by the current passing between the main electrodes. By this device the heating is fairly well distributed over the hearth. Some method of this sort is requisite for phosphorus, as the intense local heating of the arc is neither necessary nor desirable. What is needed is a moderately high temperature applied internally and diffused through the considerable mass of material constituting the charge. Even with all such precautions it is not easy to heat a large furnace uniformly, and the units of plants are still relatively small. But in spite of this the real merits of internal heating are so great that the electrical process is now without a rival. Another form of phosphorus furnace is shown in Fig. 16. It is practically a Siemens crucible furnace, closed so as to prevent the exit of gases except through the determined outlet, *D*, through which the phosphorus distills. The upper electrode is water jacketed. Another substance for the manufacture of which the electric furnace presents substantial advantages is carbon disulphide. The reaction between carbon and sulphur is endothermic, and it is evidently preferable to impress on the raw materials the requisite heat by an internal method of heating rather than to pour it in laboriously and expensively through the walls of a retort.

Electrical Roasting Furnaces.—The furnaces which have been described above are from the nature of the case chiefly concerned in the production of high temperatures. When moderate temperatures—e. g., up to a white heat about 1,400 deg. C. = 2,552 deg. F.—are required, gas or solid fuel furnaces of well-known types are generally preferable, and certainly much cheaper under ordinary conditions. At still lower temperatures—for example, a moderate or a dull red heat—the case against the electric furnace is even stronger. One may, however, find instances when the use of the electric furnace is practicable for very moderate temperatures. Already low temperature electric furnaces are in successful use for laboratory purposes, and for the little muffles employed in mechanical dentistry. I propose to extend their employment, given suitable conditions, to industrial operations. In modern metallurgical practice it not infrequently happens that an ore of paying richness occurs in a district where fuel is dear or hardly existent and the means of communication so bad that the cost of imported fuel becomes almost prohibitory by the time the fuel is delivered on the spot. Such desolate regions, from the nature of the case, are generally mountainous and often abundantly supplied with water power. The enterprising exploiter of a property of this kind naturally turns to some electro-chemical process of treatment, and if the water power can be readily utilized without an unduly large expenditure for impounding, tunneling and the like, there is no reason why the absence of fuel should prevent the successful and profitable extraction of the valuable constituents of the ore. But it often happens that electro-metallurgical processes need some preliminary aid from older methods. Frequently, for example, the ore has to be roasted.

In the case now being considered, as fuel is very dear, an alternative mode of heating is desirable, and this can be secured by an electrical method. The cost even with cheap water power would be excessive under ordinary industrial conditions, but in the special circumstances cited it may fall within moderate bounds.

As long ago as 1883, Faure patented a furnace, illustrations of which are here shown (Figs. 17 and 18), designed for raising the temperature of a charge lying on the hearth of the furnace by heat generated in a continuous conductor embedded in the sole of the furnace. An obvious alternative is to let the conductor lie on the hearth itself or embed it partially. This furnace was intended for the manufacture of sodium, but, as far as I know, was never put into use. It will serve here as an example of a simple method of internally heating a reverberatory furnace suitable for roasting operations. It would be easy to devise other forms to meet special needs. The temperature required is so moderate that the practical difficulties are smaller than most of those encountered in electro-chemical work. Without setting myself seriously to the design of such a roasting furnace, I should say that a fire-brick hearth in which grooves were chased so that iron rods of fairly large sections were embedded nearly flush with the level of the hearth would serve as well as more elaborate contrivances. I should use a low pressure and a heavy current, so that the iron rods might be stout enough to resist wear and loss by oxidation. They could be easily and cheaply renewed. Systematic roasting in a revolving calciner, instead of on a fixed hearth needing rabbles and much hand labor, would be accomplished at least as easily as any form of roasting by fuel in a similar apparatus. Roasting furnaces needing plows or rakes dragged over the hearth mechanically to stir the ore would be better suited by the electrical method of heating than by the usual roasting processes; the wear and tear of such forms of mechanism is heavy, and is largely due to their exposure to the fire-gases which heat the ore. With an electric roaster this would be changed, the sole of the furnace being the hottest part, the ore the next, and the plow, or stirrer, remaining fairly cool. There are certainly possibilities in the electric roaster when power is sufficiently cheap and fuel is sufficiently dear.

In this paper I have purposely abstained from deal-

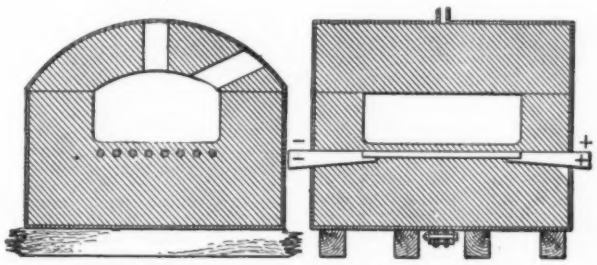


FIG. 17.

FIG. 18.

ing with electrolytic processes, such as that of Héroult for aluminium and of Castner for sodium, because these operations are not characterized by the use of the electric furnace. It is true that the bath is hot and that the heat is generated electrically, but the process *qua* process depends on the electrolysis of the bath, and the fact that the bath is electrically heated is merely incidental. It follows that the principles necessary to be observed for successful working differ widely from those which claim attention in the electric furnace used in its proper and limited sense. In addition to the reasonable objection which can be based on this divergence in subject matter, there is a highly practical obstacle arising from the difficulty of properly discussing this second group of processes in the space and time available. The matter is of great importance and considerable complexity, and should be handled as a distinct subject—not relegated to the position of a mere appendix or addition to a paper on another question.

In concluding, it may be permitted to make a kind of summary which shall set out the existent or probable applications of the electric furnace to industrial needs and to the preparation of novel and useful materials. At the beginning of this paper it was stated that "the function of an electric furnace is to produce a temperature of a degree or in a place unattainable by other means." With this dictum as a guide the examples cited above range themselves in an orderly, coherent scheme. It will be found that

other cases which may arise can be classified thus, for when the substance to be prepared requires for its production a temperature above that attainable by combustion, it must be made by the electric furnace according to our present knowledge, and when it has to be produced at a fairly high temperature in an inclosed space, and with an exclusion of air, electrical heating, though not a necessity, commonly presents great advantages. These two conditions—the need for a high temperature and the application of internal heating—substantially determine whether a given reaction will be better performed by electrical energy or by some more familiar means of heating. These canons, when applied, give the following groups: First, products for which the electric furnace is indispensable. These are calcium carbide, carborundum—both already in large use—carbon boride, fused quartz in quantity, graphite, the diamond and the ruby, as imminent industrial possibilities. Secondly, those substances which may be prepared by other methods, but are difficult to manufacture economically by any external method of heating. Such are zinc, phosphorus and carbon disulphide. I would add steel, for to heat this most delicate material in contact with ordinary fuel and its products of combustion is to invite disaster. Siemens realized this clearly enough, and if our friends at Sheffield were a little less tied by tradition his ideas would have been in successful operation 20 years ago. These two groups provide a field of work wide enough and diversified enough to satisfy the most ardent investigator or the keenest industrialist. I have endeavored to point out where honor and profit may be sought, and I am confident that the competent seeker will reap an abundant harvest. The institution which I am addressing has already shown an appreciation of the industrial and commercial importance of electro-chemistry, and to it I would respectfully commend the fostering of this branch of its activities.

AN ELECTRO-CHEMICAL EXPLANATION OF THE USE OF CADMIUM IN TESTING STORAGE BATTERIES.

By E. C. HANDY.

IN connection with the modern storage battery cell, experts recur to the use of metallic cadmium in making tests of a discharge, and it is my desire to advance a short explanation of the reactions taking place, and the use of said metal, in this connection.

The storage cell defined is nothing more or less than a voltaic or primary combination, differing from other primary cells, in that its energy can be restored by recharging. That is to say, its electro-negative-portion (PbO_2), lead peroxide, which has been reduced, and its electro-positive portion (Pb), lead, which has been oxidized to Pb_2O or PbO, lead suboxide or oxide, during the discharge, can be restored to their original difference of potential by passing an inverse current long enough to reoxidize the positive electrode, and to reduce the negative. This is accomplished by the elements of water in the sulphuric acid solution, namely, oxygen and hydrogen.

Now cadmium is a metal slightly electro-negative to the metal lead, but electro-positive to its oxides, and the more oxygen in combination with the lead, the more electro-positive is the cadmium to that oxide.

By electro-positiveness of a metal, we mean its power of originating a higher E. M. F. in an electrolyte than the other metal of the couple.

Now let us presume a storage cell to be charged to a potential of 2.1 or 2.2 volts.

Lead, the negative pole of the couple, is strongly electro-positive to its oxide, PbO_2, the positive pole of the couple; and although each pole tends to exhibit a certain E. M. F., that of the electro-positive portion, lead, exhibits a greater force than that of its oxide, the positive electrode; and in spite of the resistance of that pole, current is forced to it from the lead, and thence out through the circuit, exhibiting a high potential.

Suppose we place cadmium in the solution. It will tend to exhibit an E. M. F. of its own according to its solubility. We attach to it the negative wire of a voltmeter, and connect the positive wire to the positive electrode of the cell, the electro-negative side of the couple, and we obtain a reading, as we would with the Pb (lead) as negative, but the reading is higher, owing possibly to the difference of solubility of the two metals.

The cadmium is thus found to exhibit a stronger E. M. F. than the positive electrode, PbO_2, and is therefore electro-positive to it, and its action is more energetic than that of the lead.

As the cell discharges the positive electrode is partially reduced to a lower oxide, such as lead sesquioxide (Pb_2O_3) or lead red oxide (PbO, PbO_2) which contain more lead and less oxygen by weight than before, and exhibit a stronger E. M. F. in opposition to the cadmium, thus tending to reduce the potential on the cadmium side, with decreasing deflection of the meter. And as the discharge continues, the positive electrode is more and more reduced and becomes weaker in per cent of oxygen, and thus it steadily evolves a stronger counter force to that of the cadmium.

The action of the electro-positive plate of the cell, which is sending a current through the electrolyte to the positive electrode, is the opposite of the preceding, as it is being steadily oxidized to lead suboxide (Pb_2O); any lead monoxide (PbO) decreases in percentage of free metal, and therefore becomes less and less electro-positive to its higher oxide.

Placing the positive voltmeter wire on the negative electrode, we observe a slight deflection, showing that the negative electrode, originally lead, which is electro-positive to cadmium, and capable of exhibiting a stronger E. M. F., cannot now do so, as enough of it has been oxidized to render its E. M. F. weaker than that of the cadmium, but only slightly so, therefore causing only a slight deflection of the voltmeter needle. Now, as the action of the discharge goes on, more and more of the lead of the negative electrode becomes oxidized to Pb_2O or PbO, and the deflection is increased. At the same time it becomes less and less electro-positive to its opposite, the positive electrode; and after a certain time it can only exhibit a much lower potential than at first. If the process of oxidization be then further continued, a point will be reached where, owing to complex chemical action no further current will be produced, and the deflection of the meter with cadmium will be greatly increased.

By the foregoing explanation is would seem reasonable to believe that if a "negative" plate could be first wholly reduced to spongy lead, and that spongy lead be prevented from oxidization in the solution of sulphuric acid, the E. M. F. of the cell could be held at 2.5 volts for an indefinite time, when in a state of charge. However, owing to the absorption of oxygen, the negative plates are soon coated with oxide, which is slowly attacked by the solution, forming lead sulphate. The positive plates are not free from this chemical corrosion, but can be left exposed to the air in a dry place for a long time without harm.

The potent cause of failure in the manufacture and care of storage batteries seems largely to be from the lack of chemical knowledge of the subject by those in charge. Negative plates are frequently left exposed to the air while wet with the electrolyte, the result being a rapid oxidization, and consequent formation of sulphate, which clings to the plate and permeates every pore, greatly reducing the effective area. This sulphate is very difficult of removal by any electrician.

The only way to remove it completely seems to be, after exhausting the cell, to turn the negatives into positives and charge them a long while at a low rate, after which they can be discharged and recharged again as negatives. This, of course, is a tedious and costly process. The sulphate can be removed, if treated by a thorough chemist, with a minimum expenditure of energy.

FIRST SAULT STE. MARIE CANAL.

THE Mining Journal, of Marquette, Mich., contains the following account of the history of the construction of the first canal at Sault Ste. Marie, Mich.:

"After much solicitation (in which Hon. Peter White, Hon. John Burt, Heman B. Ely, Gen. Cass, Gov. Felch and James L. Conger and others were active), Congress, on August 26, 1852, appropriated 750,000 acres of land for the construction of the Sault Ste. Marie ship-canal. But the action of Congress was not taken without opposition. It seemed impossible for some of the older members to conceive of any sudden growth of our country such as we are familiar with. The Pacific railroads were not dreamed of. Alaska was a region in close proximity with the north pole; and yet to-day one of the most familiar trips made is along the lines of these railroads and to this much dreaded Arctic region. When the canal around the rapids of Sault Ste. Marie was contemplated many were opposed to it, and Mr. Henry Clay, of Kentucky, took occasion to speak of the work as one beyond the range of the remotest settlements of the United States or of the moon. But the general government having acted favorably, the Legislature of the State of Michigan gave its approval and the Governor on February 12, 1853, was authorized to appoint the following commission to construct the canal: Chauncey Joslin, Henry Ledyard, John P. Barry, Shubial Conant and Alfred Williams. These gentlemen in April, 1853, entered into a contract with Joseph Fairbanks, J. W. Brooks, Erastus Corning, August Belmont, H. Dwight, Jr., Thomas Dyer, principals, and Franklin Moore, George T. Porter, John Owen, Henry P. Baldwin and James F. Joy, sureties. These were some of the terms of the contract: The canal was to be finished May 21, 1855, and two combined locks were to be built, 350 feet long and 70 feet wide, with 12 feet of water on the miter sill, this afterward being increased to 13 feet; and the canal which was to extend to the head of the rapids to be 5,548 feet in length. On the date named a certificate was signed to the completion of the canal by Kingsley S. Bingham, Gov. Shubial S. Conant, Chauncey Joslin, Henry Ledyard and Alfred Williams. A certificate was also signed by John T. Clark, engineer, on May 2, and thus one of the most remarkable engineering works was completed, and one that had an immense effect on the development of the country. The estimated cost was $557,739, but the actual cost was nearly double, being $999,802.46. When we consider all the conditions under which this canal was built we are filled with astonishment. No such canal and locks up to that time had ever been constructed and the only experience to be had was from the Erie Canal where the width was only 70 feet and the depth 7 feet, the lock being 96 feet long, and about 20 feet wide with a lift of about 10 feet. Perhaps in an ordinary climate the construction in the time given would not have been prohibitory, but in the region of Lake Superior, where winter commences in October in some years and extends until the middle of May, the season was altogether too short. There was no labor to be had near at hand and cholera broke out among the laborers so that everything seemed to oppose the completion of the work, and if there had not been wonderful energy displayed, and if the directors had not been almost prodigal in the expenditure of money, the work would have been a failure; as it was, the value of the land that was received at the time was compensation for the money expended."

Bicycles in Paraguay.—Consul Ruffin reports from Asuncion, January 31, 1902:

Bicycles are being introduced here in considerable numbers, owing to the fact that the streets in the city are being paved and some of the suburban thoroughfares placed in good order. This is a new market for bicycles, and those which are particularly desired should be from 65 to 70 centimeters (25.6 to 27.5 inches) in diameter, weighing 16 to 18 kilogrammes (35.6 to 39.6 pounds). The cost should be from $16 to $18. In order to introduce the wheel here, three or four samples should be sent. The importation of bicycles is free this year, but it is likely that next year a duty will be placed thereon. Carriages, also, are permitted to come free. Most of the bicycles now in use have come from England and Germany.

TRADE NOTES AND RECIPES.

New Process of Manufacture for Varnishes and Paints.—By this process varnishes and paints are prepared by employing either liquid carbon chlorides, and especially carbon tetrachloride, or hydrocarbon chlorides, with the exclusion of chloroform.

For the manufacture of varnishes or paints with carbon tetrachloride, resins, oils or coloring substances are dissolved and diluted in this product, or the tetrachloride is employed as solvent only at the moment of application, as in the case with turpentine oil.

The chlorides of carbon, and especially the tetrachloride, very volatile and solvent, produce uninflammable, siccative and stable varnishes and paints.—French Patent of M. Leroy.

Confectioners' Colors.—For various shades of red use liquid cochineal, solution of carmine, tincture or compound tincture of cudbear, formulas for which may be found in the National Formulary. The following coal tar colors have also been recommended as producing satisfactory shades of red; they are said to be harmless; fuchsin, acid fuchsin, rocellin. Bordeaux red, ponceau, erythrosin, eosin and phloxin. For blue use Prussian or ultramarine blue, or the aniline dyes, Lyons blue, light blue or Coupier's blue. Yellow—Carmine lake, saffron, turmeric or fustic. Green—Mixture of one of the blues with yellow or the aniline dye; Malachite green may be used for the purpose. Purple—Paris violet or methyl aniline. For coloring sugar used by confectioners and bakers, the following method furnished by a manufacturer may be employed: Take any number of pounds of mold A sugar, sieve, rejecting everything save the large white crystals; place them in a candy pan, add a little red color, either prepared cochineal or carmine, and with the hands rub the color thoroughly through the sugar until it is red as desired. Then spread out on trays or on large sheets of heavy paper to dry. Sugars having other colors, such as orange, green, yellow, etc., may be produced by proceeding in the same manner, using suitable coloring agents.—Pharm. Era.

The Production of Iridescent Films on Paper, Celluloid, etc.—While the process is quite simple, you will find that it requires a good deal of practice to make a decent job of it, especially where the surface to which the film is to be applied is a large one. The liquid is prepared as follows:

Copal	2 parts
Sandarac	2 parts
Dammar	4 parts
Rosin, virgin	1 part
Benzol, q. s., to dissolve.	

When the gums and resins are dissolved add 1 part of absolute alcohol and about one-half of the total volume of the mixed solution of a mixture of the oils of bergamot and rosemary. Put in the water bath, and evaporate down to about the consistency of castor oil, when the liquid is ready for use. Have ready a bowl or basin of the proper size, filled nearly to the top with water carrying about 1 per cent of glue in solution, and with a feather or other agent apply a small amount of the liquid to the surface of the water. It will instantly spread out and cover the top of the water with a brilliantly iridescent film. The transference of the film to the object is where the difficulty arises, and skill and practice come into play. With a specially contrived vessel the paper can be slipped under the film, and the latter floated to place, but those accustomed to handling the films remove them and place them on the surfaces to be decorated with ease and rapidity.—National Druggist.

Window Glass becomes dull during storage by reason of the presence of much alkali. It has been shown that a durable glass can be obtained by the use of equal parts of molecules of aluminium, trisilicate, lime, and alkali, also that with a larger proportion of silicate the amount of the alkali can be increased; and again that the silica may be decreased, provided the lime be increased in relation to the alkali. According to M. Stoermer, in Sprechsaal, good results can be obtained by adjusting the proportion of silicate, lime and alkali to 5.32:1:1, e. g., by taking sand 160 parts, calcined sodium sulphate 75, powdered marble 50, and coke 4 to 5 parts. About three parts of the sodium sulphate may be replaced by an equal quantity of potash; and, in one instance where the pots in the corner of the furnace required about three hours longer than the rest, it was found possible to accelerate these by replacing six parts of the sodium sulphate by potash.

Tailors' Chalk.—Colored chalk for use in marking cloth may be made by mixing ultramarine ocher or other non-poisonous pigment with pipe clay, beating into a stiff mass with water and subjecting to heavy pressure in suitable molds which should be slightly oiled to prevent the mass from adhering. Thin slabs of talc (known also as French chalk) have long been in use by tailors for marking cloth and are quite satisfactory.—Drug. Circ. and Chem. Gaz.

To Bleach Tallow.—The simplest process of bleaching fats (as well as other substances) is exposure to the rays of the sun. This is inconvenient in the case of a fat which is solid at the ordinary temperature, as it is of course necessary to have it in thin layers, and these will cover much space. There is risk too of developing rancidity by prolonged exposure.

A more feasible method is to add to the fat, kept liquid by a gentle heat, one-fifth of its weight of a mixture of equal parts of kaolin and water, stirring well for some time and then allowing the fat to separate.

Freshly burned animal charcoal would perhaps be a more satisfactory decolorizer than kaolin, but it is more expensive to start with, and not so easy to regenerate.

Exposure of tallow to the action of steam under high pressure (a temperature of 250 deg. or 260 deg. F.) is also said to render it whiter and harder.—Drug. Cir. and Chem. Gaz.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Free List in Australia.—Consul-General Bray sends from Melbourne, February 14, 1902, a list of the minor articles to be used in the manufacture of goods in Australia which are admitted free of duty, as follows:

Manufacture of bellows.
Hoops.
Pipes.

Manufacture of blinds.
Actions, patent.
Eyes.
Holdfasts.
Knobs, screw.
Pulleys.

Manufacture of boots and shoes.
Beadings, up to 1½ inches in width.
Boxes, spur.
Caps, toe, metal.
Circlets.
Clasps, iron for clogs and pattens.
Fasteners, button.
Heels, wooden, with or without leather covering.
Heels for clogs and pattens.
Nails, heel.
Plates, heel.
Plates, toe.
Plugs.
Seamings, up to 1½ inches in width.
Shanks and shanking.
Strappings, back, up to 1½ inches in width.
Tips, heel.
Top banding.
Welts and facings, up to half an inch in width.

Manufacture of fishing rods.
Butt caps.
Counters.
Ends.
Ferrules.
Hitches or catches.
Rings.

Manufacture of furniture.
Cane or ferrules for bamboo furniture.
Nails, fancy.

Manufacture of harness, saddles, and whips.
Foundations, iron, for winkers.

Manufacture of hats and caps.
Braids.
Galloons (hat) up to 1½ inches in width, plain colors.
Leathers, real or imitation.
Peaks (cap), except leather or embroidered.
Tassels.
Ventilators.

Manufacture of metals.
Agricultural, horticultural, and viticultural implements.
Check bits.
Mouthpieces for chaff cutters.
Fingers.
Sections for reapers.

Manufacture of parasols, sunshades, and umbrellas.
Caps.
Mounts, except gold or silver.
Notches.
Swedges.
Tassels.
Tips.

Manufacture of vehicles.
Bar mountings.
Back lights.
Buckles and buckle loops.
Barrels, curtain.
Beading and bead finishers.
Bow sockets.
Buttons.
Clips.
Collars.
Couplings, shaft and pole.
Ends.
Eyes.
Fasteners, apron, curtain, sent, and patch.
Irons, slat.
Ivories.
Joints, stump.
Knobs.
Plates, felly.
Props, and nuts for same.
Shackles.
Slides, seat.
Steps and step treads.
Stops, shaft.
Tassels.
Tips.
Whip sockets.

Miscellaneous manufactures.
Bottle stoppers:
China top and wire fasteners for attaching to bottles.
Screw, made of lignum-vitæ.
Internal, viz., marble, lignum-vitæ, vulcanite, or ebonite.
Caps for cartridges.
Eyelets and rings, sail and sacking for tents and tarpaulins, etc.
Gas tips:
Lava.
Steatite for gas fittings.
Screws:
For handles.
For hinges, without nuts, for coal scuttles.
Lock and stove, up to 4 inches.
Stars and knobs, with screws.
Springs for leggings.
Knobs and feet for fenders.

Comparative Advantages of the Sea and Canal Routes to the Baltic.—The Department has received from Consul Freeman, of Copenhagen, under date of March 5, 1902, a statement from the Danish point of view as to the comparative advantages of the sea route and the Kiel Canal route to the Baltic. In a report from Berlin, published in "Advance Sheets No. 1190" (November 15, 1901)—"Consular Reports No. 256" (January, 1902)—it was claimed that the canal dues paid by the U. S. S. "Enterprise" amounted to 400 marks ($95.20) and those of the U. S. S. "Buffalo" to 900 marks ($214.20), "which would apparently indicate that it is less expensive for our ships to go through the Kaiser Wilhelm Canal than to round the Danish Peninsula, taking into consideration the saving in time and coal." Consul Freeman states that the Danish advocates of the sea route, touching at points in Denmark, contend that, according to the orders of the United States Navy Department, ships rounding the Danish Peninsula are not under steam, but under sail, so that the expense for coal is nothing. Coal would have to be consumed in the passage of the canal and the Elbe. In the second place, the pay and subsistence of the officers and men are just the same at sea as in harbor, so that the saving in time, if time means expense, was nothing. It is thus claimed that for those two ships to go through the Kiel Canal cost the United States government 1,300 marks ($309.40) more than it would if the ships had gone round the Danish Peninsula.

As to vessels in the merchant service, the captain of a steamer coming through the English Channel past Dover has before him the two routes—through the canal or round the peninsula. The two routes come together again at Bornholm, in the Baltic. It is 200 miles shorter via the canal—that is, for an ordinary steamer, twenty hours' time; but about ten hours of this is lost by the necessarily slow speed in the Elbe and the canal. Often, the remaining ten hours is also lost in gaining the mouth of the Elbe, on account of the fog and tide and because of detentions in the canal while waiting for ships going in the opposite direction. Even if it is not lost, the captain has before him the question whether the fuel and expense of the crew for ten hours will amount to as much as the canal dues.

For vessels coming north of Britain or from Scottish ports, or from Newcastle, West Hartlepool, or Hull, the route around the peninsula is, of course, shorter and cheaper.

The report above quoted from says, further, that "it has been possible to maintain the traffic" in the canal "without any interruption from ice, even throughout the severe winter of 1896-97, when the sound and belts were blocked with ice."

The traffic in the Danish Sound, it is claimed, has not been closed since 1895-96, except that in severe winter of 1896-97, for five days, the assistance of ice breakers was in some cases called upon to clear the way for ships. The Copenhagen Harbor Board now has command of such powerful ice breakers that it may be safely expected that open traffic will be maintained. There is always a strong current running one way or the other in the Danish Sound and belts, amounting to at least 6 miles an hour. It would be difficult for ice to close a channel like that. It would remain open long after the still waters of the canal and the bay at its eastern terminus were closed with ice.

As to the canal remaining open after the Danish Sound and belts were closed with ice, it is argued that the canal would then be of no use, for long before the sound and belts, with their free connection with the North Sea, were obstructed, all the Baltic ports would be closed and inaccessible, the Baltic itself would be filled with ice, and a vessel coming through the canal to the Baltic, supposing the canal to be open, could not reach a port and would have nowhere to go.

It is observed that from February 12 to the date of the Consul's report, March 5, 1902, official telegrams from the Kiel Canal state: "Navigation closed for sailing vessels;" but the Danish Sound and belts have been perfectly free from ice every day during this winter.

How to Increase Our Trade in Germany.—In a recent interview with a prominent merchant, I obtained data as to the expansion of our trade abroad, which I submit for the information of American exporters.

Our goods would experience an enhanced sale in many lines if they could be bought directly from stock kept on hand in foreign countries. This is especially true of articles not yet well known in the world's markets or which come from manufacturers who have transacted but a limited business abroad.

The long time necessary to obtain goods from the United States is an obstacle to our trade. Sometimes it takes three months from the date of order until the goods are received. If foreigners had the opportunity to see our superior articles and to get them at a reasonable price within a few days, sales would be much more easily effected.

There is a great conservatism in trade here and many merchants will not change their sources of supply, unless they can do so without difficulty and delay. Others confine their purchases to such quantities as are needed for immediate use. In all these cases, a permanent stock in the principal centers of trade would be the best means of successfully introducing our goods.

Warehouses with great varieties of articles are doing an excellent trade here. To secure the best results, concerted action and systematic effort on the part of our exporters are needed.—Charles Neuer, Consular Agent at Gera.

Steamship Service Between New York and Constantinople.—German iron circles look upon the direct freight service which has been inaugurated by the Hamburg-American and Levante lines between New York and Constantinople with misgivings.

It is taken for granted that the United States will at once improve the opportunity and enter into lively competition with the German trade in the Orient.

The central organ of the German rolling mills expresses surprise that a German steamship line should have been ready to inaugurate an enterprise opposed to the interests of German industries.

A mitigating reason for the Levante Line, it is said, may be found in the fact that it has operated without profit for seven years, and is therefore compelled to take hold of every opportunity to increase its revenues. Nevertheless, the paper claims, Germans have a right to expect that the new line will adopt freight rates compatible with the interests of the German export industry, so that the greatest damage will at least be avoided. This expectation, the paper states, is also shared in government circles.—Richard Guenther, Consul-General at Frankfort.

Margarin and Artificial Butter in Belgium.—Consul Roosevelt reports from Brussels, March 5, 1902:

A manufacturer of artificial butter resembling the natural product was recently prosecuted for selling it under another name than margarin. The court decided that the product could not be assimilated with margarin and acquitted the manufacturer. As dealers in natural butter consider that their trade will thereby suffer, they have petitioned the Minister of Agriculture that the law of May 4, 1900, be amended to read as follows:

"Article 2. All natural fat other than butter of whatever origin, animal or vegetable, having undergone, for the purpose of sale, a mixture in any way whatever with any other fat, natural or artificial, and presenting one or more exterior characteristics of butter, such as appearance, consistency, color, smell, taste, or degree of firmness, is designated under the name of margarin."

The petition also requests that several modifications be made in packing, in the labels or signs of margarin dealers, and in the placing of margarin near natural butter during transportation.

American Looms in Switzerland.—Among the American exportations of the coals-to-Newcastle kind may be mentioned the recent rather large shipments of ribbon looms to Switzerland. Even the men who buy them express surprise at finding themselves using an imported article in place of one which for generations has been manufactured here. These looms are much more expensive than those made in Switzerland, even leaving freight and duties out of account; but manufacturers find it profitable to use them because of their greater solidity of construction and the much larger amount of work they do. If it were not for the difficulty of readily adjusting them for the production of different widths and kinds of tissue, they would no doubt soon displace all other looms for weaving plain ribbons. But they are built to produce only one article, or a small number of articles of a particular kind on a large scale, after the American fashion.—George Gifford, Consul at Basel.

Lime and Sand Stone Building Bricks.—Consul Baehr sends the following from Magdeburg:

Referring to my report of March 21, 1901,* relative to artificial building stone made of lime and sand, I have received numerous inquiries from interested parties in the United States, requesting me to state minutely the details of this process. In response to this request, I have investigated this industry carefully, and I take this means of stating the result, as it is impossible to answer all who inquire.

I would refer interested parties to the firm of H. Huennekes & Co., 120 Liberty Street, New York city, who can answer all questions and give full particulars about the so-called "System Huennekes." It is perhaps the simplest system in existence, and produces a thoroughly sound and weatherproof brick at a small cost.

I think this industry will make great strides in our country, as we have quantities of sand, which is the principal substance used in the manufacture of these bricks.

United States Glassware in Brazil.—Two years ago I persuaded one of the principal dealers in glass and crockery here to order glass and chinaware from the United States, and later I was informed that the venture had been quite successful and that he had established a profitable trade in those articles.

Yesterday, the most prominent dealer in that line in Rio called on me with the request that I should furnish him with addresses and catalogues of American glass factories, saying that since the other firm had introduced American goods, a general demand had arisen for them, and he would be obliged to carry them. He said he thought there was a great future for them in Brazil.

If American houses will furnish me with catalogues, I shall be pleased to distribute them where they will do the most good. I would also suggest that similar catalogues be sent to the consuls in Pernambuco, Para, and Bahia, calling attention to the successful introduction of these wares in Rio. Manufacturers and dealers should bear in mind, however, that there is a demand for only the very best goods, particularly in imitation cut glass.

I can not emphasize too strongly that the utmost care should be exercised in packing these goods, in order to avoid great losses and inconvenience. All merchandise arriving here by steamer is discharged in lighters, and as a rule is handled very roughly. A Rio firm which at my request ordered chinaware in the United States complained repeatedly that the goods received were packed so badly that there was a loss of quite 50 per cent in breakage; while in the consignments from Europe, there was hardly any loss of that kind, the packing being done with so much more care.—Eugene Seeger, Consul-General at Rio de Janeiro.

Brazilian-United States Steamship Service.—Under date of February 5, 1902, Consul-General Seeger reports from Rio de Janeiro that the Lamport and Holt Line is about to add six steamers to its service between that port and New York. Two of the boats will be of about 5,000 tons dead weight each, with accommodations for 70 cabin and 50 steerage passengers. The others will carry 6,350 tons dead weight and will be fitted with shade decks, so as to be available for cattle transportation.

The Prince Line, continues Mr. Seeger, has also added a boat to its New York-Rio service. It has a capacity of 4,560 tons and draft of 22 feet; good accommodation for 12 passengers; and electric light all through. This is the first of four steamers specially constructed for this trade. The boats can stow up to 70,000 bags of coffee, and this special vessel is well suited for delicate cargoes. It will make the trip between New York and Rio in about eighteen days.

New Department in Honduras.—Under date of March 3, 1902, Consul Johnston writes from Utila:

The Congress now in session in this republic has formed a new department on the north coast, called Atlantida. It extends from Tela on the west to Belfata on the east, being about 60 by 50 miles, and taking in the rich banana land along the coast. The seat of government will be at La Ceiba, and the law will go into effect September 15, 1902. Action is being taken at La Ceiba in regard to the putting in of waterworks and other improvements. The change will cause much building there, especially as lumber has been put on the free list for one year.

Australian Wool for the United States.—Consul-General Bray, of Melbourne, under date of February 15, 1902, reports that the total shipments of wool from Melbourne to the United States during the season 1901-2 amounted to 28,258 bales, against 26,942 in the previous season, or an increase of 1,316 bales. The consul at Sydney reports shipments to the amount of 7,535 bales from that port, making a total of 35,793 bales shipped from Australia to the United States.

Opportunity for American Harness and Saddlery in Syria.—Vice and Deputy Consul Magelssen writes from Beirut, February 25, 1902, that there is a good market for American harness and saddlery in that city, if these goods are introduced at prices low enough to meet European competition. There are over 500 carriages in Beirut alone, but the consul knows of no attempt on the part of an American house to secure this trade.

* Advance Sheets No. 990; Consular Reports No. 248.

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No. 1321. April 21.—Coal, Steel, and Iron Production of France in 1901—Regulating Trusts in Germany—Prohibition of Mining in Eastern Siberia—Dental Practice in Uruguay—* Opening of Argentine Ports to Live Stock—* Mill Saws in British Columbia.

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No. 1326. April 26.—New Weaving Brake in Germany—* British Demand for American Shooks.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

SELECTED FORMULÆ.

Cold Creams.—

1. Oil almond	425	parts
Lanolin	185	parts
White wax	62	parts
Spermaceti	62	parts
Borax	4.5	parts
Rose water	300	parts

Melt together the first four ingredients, then incorporate the solution of borax in the rose water.

2. Tragacanth	125	grammes
Boric acid	100	grammes
Glycerin	140	grammes
Expressed oil of almonds	50	grammes
Glyconin	50	grammes
Oil of lavender	0.5	gramme
Water.....enough to make	1,000	grammes

Mix the tragacanth and the boric acid with the glycerin; add the almond oil, lavender oil, and egg glycerite, which have been previously well incorporated, and, lastly, add the water in divided portions until a clear jelly of the desired consistency is obtained.

3. Oil of almonds	26	ounces
Castor oil (odorless)	6	ounces
Lard (benzoated)	8	ounces
White wax	8	ounces
Rose water (in winter less, in summer more than quantity named)	12	ounces
Orange-flower water	8	ounces
Oil of rose	15	minims
Extract of jasmine	6	drachms
Extract of cassia	4	drachms
Borax	2	ounces
Glycerin	4	ounces

Melt the oil of sweet almond, wax and lard together, and stir in the castor oil; make a solution of the borax in the glycerin and rose and orange-flower waters; add this solution, a little at a time, to the melted fat, stirring constantly to insure thorough incorporation; finally add the oil of rose dissolved in the extracts, and beat the ointment until cold.—Bulletin of Pharmacy.

Some Effervescent Powders.—

MAGNESIAN LEMONADE POWDER.

Fine white sugar	2 pounds
Magnesium carbonate	6 ounces
Citric acid	4 ounces
Essence of lemon	2 drachms

Rub the essence into the dry ingredients, work well together, sift, and bottle.

MAGNESIAN ORGEAT POWDER.

Fine sugar	1 pound
Carbonate of magnesia	3 ounces
Citric acid	1 ounce
Oil of bitter almonds	3 drops
Vanilla flavoring	q. s.

Thoroughly amalgamate the dry ingredients. Rub in the oil of almonds and sufficient essence of vanilla to give a slight flavor. Work all well together, sift, and bottle.

RASPBERRYADE POWDER.

Fine sugar	2 pounds
Carbonate of soda	2 ounces
Tartaric acid	2 ounces
Essence of raspberry	4 drachms
Carmine coloring	q. s.

Rub the essence well into the sugar, and mix this with the soda and acid. Then work in sufficient liquid carmine to make the powder pale red, sift through a fine sieve, and pack in air-tight bottles.

AMBROSIA POWDER.

Fine sugar	2 pounds
Carbonate of soda	12 drachms
Citric acid	10 drachms
Essence of ambrosia	20 drops

Amalgamate the whole of the above, and afterward sift and bottle in the usual manner.

NOYEAU POWDER.

Fine sugar	2 pounds
Carbonate of soda	12 drachms
Tartaric acid	10 drachms
Essence of noyeau	6 drops

After the dry ingredients have been mixed, and the essence rubbed into them, sift, and bottle the powder.

LEMON SHERBET.

Fine sugar	9 pounds
Tartaric acid	40 ounces
Carbonate of soda	36 ounces
Oil of lemon	2 drachms

Having thoroughly mixed the dry ingredients, add the lemon, rubbing it well in between the hands; then sift the whole thrice through a fine sieve, and cork down tight.

As oil of lemon is used in this receipt, the blending must be quite perfect, or when the powder is put in water the oil of lemon will float.

Any other flavoring may be substituted for lemon, and the sherbet named accordingly.

CREAM SODA POWDER.

Fine sugar	30 parts
Tartaric acid	7 parts
Carbonate of soda	6 parts
Finely powdered gum arabic	1 part
Vanilla flavoring	q. s.

Proceed exactly as for best lemon sherbet.—National Druggist.

To Polish Mahogany.—The Leipziger Drechsler Zeitung gives the following recipe for imparting polish to mahogany: Pour oil (preferably good drying varnish) over alkanna root, whereby the latter is extracted, dyeing the oil a dark red. The mahogany is rubbed with this before polishing, and thus assumes a more vivid color. Walnut may be treated in a similar manner.

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